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Quality in IS Research: Theory and Validation of Constructs for Service, Information, and System

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Quality in IS Research: Theory and Validation of Constructs for Service, Information, and System

BY

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ACCEPTANCE

This dissertation was prepared under the direction of the *Yi Ding* Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctoral of Philosophy in Business Administration in the Robinson College of Business of Georgia State University.

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ABSTRACT

Quality in IS Research: Theory and Validation of Constructs for Service, Information, and System

BY

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IS quality is an important concept. Basing their model on information communication theory, DeLone and McLean formulated Information Quality and System Quality as two quintessential elements in their 1992 IS Success Model. In recent years, DeLone and McLean (2003) added Service Quality to form a triumvirate of antecedents to success. Unfortunately, the addition of this construct has unintentionally uncovered an overall lack of coherence in the theoretical modeling of IS Success. Research to date on IS Service Quality has largely ignored the impacts of Information Quality and System Quality when service is delivered through an information system (IS).

We believe deeper theoretical insights are needed to reconceptualize Service Quality and rationalize IS quality. After reviewing related literature, we apply marketing exchange theory as a reference framework to redefine service related terms and identify possible scenarios of delivering service through systems. Thereafter, we model IS quality in a new way, based on analysis of alternative scenarios. In validating our proposed model, we discuss our research

methods and data analysis that will serve as empirical evidence. In particular, we focus on content validity, construct validity, nomological validity, and unidimensionality of the three IS quality dimensions: System Quality, Information Quality, and Service Quality.

By furthering our understanding of IS quality, we hope to initiate coherent theory development; this exercise should then lead to a theory that integrates IS quality elements and helps organizations implement effective strategies for using IS to deliver service. Through the empirical validation of IS quality model, we contribute an empirical assessment of content, construct, and nomological validity of the IS quality constructs, as proposed by DeLone and McLean in their 2003 updated IS success model.

Table of Contents

List of Tables

List of Figures

1. INTRODUCTION

1.1 Gaps in IS Quality Research

How can academics and practitioners accurately evaluate the success of information systems (IS)? There have been a myriad of IS studies attempting to define and theorize systems success, but these efforts have been only partly satisfactory. DeLone and Mclean [D&M] (1992) is seminal in this regard, but their 2003 study adds constructs and new paths to their original IS success model that are not encompassed by their original theory base. This renders the 2003 model interesting, but not completely coherent. And, therefore, we ask: What can be done to create a stronger, all-encompassing theory base for this seminal model of IS success?

DeLone and Mclean are in a select company of IS researchers who have studied IS quality. Researchers have applied concepts from economic theories (Feltham 1968; Marschark 1971; Kriebel and Raviv 1980), theories based on information communication theory (Shannon and Weaver 1949; DeLone and McLean 1992; DeLone and McLean 2003), and marketing Service Quality instruments like SERVQUAL to the study of IS quality components. System quality, Information Quality, and Service Quality have been the three main foci of this pursuit, but in spite of decades of attention to this phenomenon, the theoretical underpinning of systems success has not been forthcoming.

What is lacking is a coherent and consistent theoretical treatment to bridge each of these separate IS quality dimensions. DeLone and McLean (1992) applied information communication theory in devising the System Quality and Information Quality dimensions, but their updating of the model in 2003 lacks theoretical grounding.

Studies in IS Service Quality have applied the marketing-originated SERVQUAL instrument to studying the quality of the human service provided by the IS department (Kettinger and Lee 1994; Pitt and Watson 1995; Kettinger and Lee 1997; Jiang, Klein et al. 2002; Kettinger and Lee 2005). Many of these studies have tended to focus their Service Quality measurement on how well customers perceive the human service providers provide the service. Unfortunately, and ironically, many service functions have been automated via sophisticated information technologies. The adding of those information technologies (IT) in business services results in new levels of coordinating complexity due to the existence of information asymmetries in economic exchange, the intangibility of service, and the scale of modern B2B (Chesbrough and Spohrerrer 2006). Often those IT-enabled services contain dynamic exchange processes that are co-generated by both providers and customers, and the involvement of the adoption or consumption process (Tien and Berg 2003). Existing studies focusing on IS support services provided predominantly by IS personnel have yielded little understanding of the impacts of systems on these IT-enabled services, services in which IT is rapidly becoming an embedded characteristic of service and contributing to creation of new service values to organizations.

Overall, these problems saddle DeLone and McLean 2003 IS Success Model (ISM) with an essentially manual view of IS service. This, coupled with lack of theoretical and empirical validation of the unidimensionality and construct validity of System Quality, Information Quality, and Service Quality, mean that much more work needs to be done in this critical domain.

1.2 Research Problems and Questions

To extend research efforts in IS quality and fill the research gap, this dissertation attempts to address several related critical research questions as listed below:

1. To what extent does IT impact service delivery, thereby changing the nature of IS service?
2. How can IS quality constructs be theoretically integrated into a coherent and broader understanding of IS success?
3. What are valid measures of IS quality constructs?
4. Is our theorization of IS quality empirically supportable?

1.3 Applied Methods

In answering those research questions, we go through three stages. In the first stage, we apply theory from the market exchange perspective (Bagozzi 1975). This allows us to explore how the characteristics of the information output, system, and interactions between users and IS, including service providers might affect each other and contribute to the overall success of IT-enabled service. From this theoretical perspective several hypotheses regarding the relationships among IS quality constructs are proposed. Subsequently, we apply the same theoretical model of IS quality to reexamine relationships between IS quality constructs (within the D&M 2003 IS Success Model) and their downstream effects including Intention to Use / Use and User Satisfaction.

For hypothesis testing, in the second stage we develop an instrument that can faithfully measure quality of IS on information, system, and service. In this stage, existing measures of IS quality in the literature are first examined and selected for theoretical appropriateness. Then, these measures are assessed for their content validity and construct validity through pretest and pilot tests. During the last stage, we apply the validated IS quality measures to test hypotheses and causal models involving main constructs of IS quality and Intention to Use /Use as well as User Satisfaction through a full scale test.

1.4 Summary

The remainder of the dissertation is organized into three sections including literature review, instrument development, and model test sections. In the literature section we first review and discuss existing research work on IS quality and service related issues. Then, drawing upon the existing literature, we apply market exchange theory (Bagozzi 1975) to put forward a theoretical IS quality model and related hypotheses. Also at this point, we review the existing measurement work in IS field on those three IS quality constructs including Information Quality, System Quality, and Service Quality. Then, in the instrument development section following this exercise, we enumerate IS quality measures for a draft instrument, which is then assessed for content validity, reliability, and construct validity. In the model testing section or stage 3, we examine the causal and structural paths in our models. We conclude this dissertation with a discussion of possible contributions, implications, limitations, and future work.

2. A Review of Quality in IS

Since a lot of existing IS studies have involved IS quality, we first start with a comprehensive literature review to identify what have been addressed and what need to be addressed about conceptualization and measurement of IS quality.

2.1 Quality Conceptualization and Measurement

Although, quality is considered to be an important IS success driver, "quality" itself is not well defined in the IS literature (Nelson, Todd et al. 2005). In the broader business literature, the concept of quality has been examined from several different perspectives. Garvin (1984) classified five approaches used by the academics to define quality: 1. the transcendent approach from philosophical perspective; 2. the product-based approach from economics perspective; 3. the user-based approach from consumer preference perspective; 4. the manufacturing-based approach from supply side engineering and production perspective; 5. the value-based approach from costs and prices perspective.

The transcendent approach considers quality to be a metaphysical concept that is hard to define and can only be understood through one's experience (e.g., Pirsig 1974). Due to its lack of practicality in providing sufficient "diagnostic information" (Oliver 1997), this approach is rarely utilized by quality practitioners. The product-based approach views quality as a variable that can be reflected by certain quantifiable characteristics of product such as durability (e.g., Leffler 1982). This view has been implicitly applied in some IS studies to develop quality measures such as system speed, accuracy, response time, etc. (e.g., Feltham 1968; Ahituv 1980; Hamilton and Chervany 1981). The user-based approach asserts that quality can only be determined by consumers (Oliver 1997). This viewed is often assumed in many marketing studies. The development and uses of SERVQUAL to measure Service Quality imply such a view in some IS studies (e.g., Kettinger and Lee 1994; Pitt and Watson 1995; Jiang, Klein et al. 2002). The manufacturing-based approach views quality as an engineering concept related to how well and how consistently a manufactured product meets its specifications or industry standards (e.g., Lundvall and Juran 1974; Crosby 1979; Deming 1982). Based on this approach, measures have been developed such as "the proportion of nondefective[s] (conforming units of output produced by the manufacturing/quality control/inspection process" (Fine 1986, p. 1304). In IS, quality standards such as ISO 9126 have been adopted by many IS practitioners to develop quality measures such as defects density, reliability, portability, etc. (e.g., Lyu 1995; Prahalad and Krishnan 1999; Kan 2002). Finally, the value based approach sees economic value as an inseparable part of the quality of a product. Garvin (1984) argued that this approach is hard to apply in practice as it is not well-defined. In IS, some economic-based quality measures were adopted in early studies (e.g., Feltham 1968; Gallagher 1974; Senn 1974).

In the management literature, Reeves and Bednar (1994) held a similar view when they classified quality into four different categories: (1) quality as excellence, (2) quality as value, (3) quality as conformance to specification, and (4) quality as meeting and/or exceeding customer's expectations.

Considering all these different views of quality, two macro-level categories can be extracted. One is the manufacturing/operational view and the other is the customer/user view (Rust, Moorman et al. 2002). For manufacturers and producers, there are two primary quality concerns: design quality and quality of conformance (e.g., Juran 1951; Garvin 1984; Reeves and Bednar 1994; Rust, Moorman et al. 2002). In IS, such a view focuses on exploring, understanding, and using IS system design and implementation related quality factors (e.g., Mohanty 1979; Goel

1985; Boehm and In 1996; Kan 2002). For customers or users, quality is often a personal judgment that concerns value, excellence, and meeting their expectations (e.g., Oliver 1997; Rust, Moorman et al. 2002).

There are two common types of quality definitions (Oliver 1997). One is based on single-stimulus representation. Within this form, quality is expressed as single terms such as usefulness, desirability, excellence, etc. In IS, quality definitions expressed with single terms such as usefulness, flexibility, completeness, etc. may be considered to be part of this form (i.e., Seddon 1997; Rai, Lang et al. 2002). It has been criticized for its possible "tautological nature" and incomplete content representation of quality constructs (Oliver 1997, p. 167).

The other type of quality definition is based on dual-stimulus representation. In this case, quality is expressed with dual terms (i.e., "affordable excellence") that usually imply a comparison between the product or service performance and standards (Oliver 1997). The standards may be defined as either ideal points or imagined excellence expected by customers. The differences between perceived performance and expected standards serve as measures of quality. For example, Service Quality measurement represented by SERVQUAL, an instrument originally developed in marketing and often used in IS, falls into this type (e.g., Parasuraman, Zeithaml et al. 1988; Pitt and Watson 1995). This approach has been criticized for its ambiguity in defining expectation standards (Cronin and Taylor 1992).

In IS, numerous studies have focused on customer perceived quality aspects of information, system, and service (e.g., Zmud 1978; Hamilton and Chervany 1981; Baroudi and Orlikowski 1988; Wixom and Watson 2001). In the following section, we review existing work in theorizing, measuring, and validating these three main IS quality aspects.

2.2 Information Quality

To many organizations, information is an important resource that can be used to sustain their competitive advantage (Barney 1991). The study of Information Quality is prevalent in IS (e.g., Feltham 1968; Zmud 1984; Baroudi and Orlikowski 1988; Wixom and Watson 2001; Zwass 2005). Measuring Information Quality has never been easy as there are different views of what information consists of and how it should be measured (Redman 2005). In the IS management literature, the Information Quality of an IS output has often been considered to be one of critical criteria in judging the performance and success of an IS. In the early days of systems, the primary format of information output was the report. Heuristic measures of Information Quality that were set forth in many IS evaluation studies included report accuracy, format, readability, reliability, timelines, etc. (e.g., Feltham 1968; Gallagher 1974; Swanson 1974; Zmud 1978; Ahituv 1980). These measures served as proxies of various constructs in different studies. Table 2-1 has various constructs captured using Information Quality measures.

Table 2-1 Examples of Information Quality Measures Applied to Constructs

Information Quality Measures	Constructs	Authors
Reliability	Value of information	Gallagher (1974)
	MIS Capability	Schewe (1976)
	Computer User Satisfaction	Bailey and Pearson (1983)
	Information Product	Ives et al (1983)
	Information Technique	Swanson (1987)
Understandability	End-User Computing Satisfaction	Doll and Torkzadeh (1988)
	Perceived Ease of Use	Davis (1989)
	Information Quality	King and Epstein (1983)
Completeness	Value of information	Gallagher (1974)
	MIS Capability	Schewe (1976)
	IS Efficiencies	Hamilton and Chervany (1981)
Usefulness	Attitude toward MIS	Schewe (1976)
	Information Quality	Rivard and Huff (Rivard and Huff 1984), Zmud (1978), Swanson (1974)
	End-User Computing Satisfaction	Doll and Torkzadeh (1988)
	Perceived Usefulness	Davis (1989)
Relevance	Value of IS changes	Feltham (1968)

	Value of IS	Ahituv (1980)
	Computer User Satisfaction	Bailey and Pearson (1983)
	Information Product	Ives et al (1983), Baroudi and Orlikowski (1988)
	Information Quality	Zmud (1978), Swanson (1987)

Recognizing the lack of consistent and comparable use of these measures of IS information output, DeLone and McLean proposed that Information Quality was a holistic construct that represented what all these measures attempt to capture, which is the effectiveness of IS semantic output. As a part of their IS Success Model, Information Quality serves as a key determinant of IS Success. From their viewpoint, Information Quality had a composite character consisting of various aspects such as “format,” “usefulness,” “relevance,” etc. All needed to be accessed to determine the final quality of IS information output (DeLone and McLean 1992, p. 84). Although Information Quality was proposed as a composite concept from the beginning, nearly all empirical studies still treat this concept as a reflective construct (e.g., Kettinger and Lee 1994; Teng, T C et al. 1995; Rai, Lang et al. 2002). That is, the indicators of Information Quality construct are treated as equivalent or interchangeable measures. Such a misspecification can, under certain conditions, “lead to both Type I and Type II errors” (Petter, Straub et al. 2007, p. 3).

Studies that did treat Information Quality as a composite concept often adopted a multidimensional model (e.g., Zmud 1978; Wang and Strong 1996; McKinney, Yoon et al. 2002; Wixom and Todd 2005). Different approaches such as intuitive, theoretical, or empirical approaches used by sundry studies to explore sub-dimensions of Information Quality (Wang and Strong 1996) make a clear and consistent understanding of Information Quality dimensions even more difficult. What is clear, though, is that dimensions such as accuracy, relevancy, representation, reliability, accessibility, etc. are commonly used (e.g., Wang and Strong 1996; McKinney, Yoon et al. 2002; Nelson, Todd et al. 2005; Wixom and Todd 2005). Often, "definition of these dimensions and their associated metrics are based on intuitive understanding or industrial experience" (Pipino, Wang et al. 2005).

An alternative measurement perspective often ignored in the Information Quality literature is the formative approach, using indicators to represent Information Quality as an index rather than a scale (Diamantopoulos, Riefler et al. 2008). A formative construct is considered to be an extreme case of a multidimensional construct, where each dimension is represented with only one measurement item (Petter, Straub et al. 2007). Whether the formative measurement of Information Quality provides equivalent effectiveness as other measurement approaches is unknown since such few studies have ever used this approach.

2.3 System Quality

Due to the technical focus of System Quality, it has received less attention than constructs such as Information Quality, User Satisfaction, etc. in the IS management literature (Ravichandran and Rai 2000). Conceptualizations of System Quality among existing IS studies also vary. From the systems development perspective, System Quality was "largely conceptualized as an intrinsic attribute of the software" (Ravichandran and Rai 2000, p. 383). From the IS user perspective, System Quality represent some aspects of a system that can provide benefits to an organization (Ives and Olson 1984).

In the past, a variety assortment of System Quality measures have been set forth (e.g., Swanson 1974; Hamilton and Chervany 1981; Vandenbosch and Huff 1997; Wixom and Watson 2001). Measurement of System Quality has centered on assessment of hardware, software, and resource utilization (Kriebel and Raviv 1980). Assessment of hardware includes measures such as response time, ease of terminal use (Swanson 1974), system flexibility (Hamilton and Chervany

1981), etc. Assessment of software includes measures such as “portability, reliability, efficiency, human engineering, and maintainability,” which were used to represent diverse dimensions as shown Table 2-2.

Table 2-2 Examples of System Quality Measures Applied to Dimensions

System Quality Measures	Dimensions	Authors
Response time	MIS Capability	Schewe (1976)
	Value of IS	Ahituv (1980)
	Quality of output	Kriebel and Raviv (1980)
System flexibility	EDP Staff and Service	Ives et al (1983)
	Information Accessibility	Swanson (1987)
	User Satisfaction	Bailey and Pearson (1983)
	Perceived Ease of Use	Davis (1989)
Reliability	User Satisfaction	Bailey and Pearson (1983)
	Capacities of DBMS	Zahedi (1985)
	Information Product	Ives et al (1983)
Integration	MIS Capability	Schewe (1976)
	Value of IS	Ahituv (1980)
Ease of use	Output Quality	Kriebel and Raviv (1980)
	End User Computing Satisfaction	Doll and Torkzadeh (1988)

DeLone and Mclean (1992) proposed “System Quality” to be an overarching construct representing the technical level of IS effectiveness, another important determinant of overall IS success. Despite the conceptualization of System Quality as a composite concept in the literature (e.g., Ives and Olson 1984; DeLone and McLean 1992; Seddon 1997), studies often use reflective indicators to capture this construct (Wixom and Watson 2001; e.g., Chen and Hitt 2002; Rai, Lang et al. 2002). However, improper specification of measurement model can lead to biases in assessing the structural model (Petter, Straub et al. 2007) and, therefore, interpretational problems.

Perhaps sensing this tendency to misspecification, a few studies have offered a multidimensional model (e.g., McKinney, Yoon et al. 2002; Wixom and Todd 2005). But the multidimensional approach requires a careful specification of the relationship between the individual dimensions and “the (second-order) latent construct” (Diamantopoulos, Riefler et al. 2008, p. 1205). Without such a clear specification, “one … can only conduct research at the dimensional level …” (Law, Wong et al. 1998, p. 741). Although the formative measurement model is appropriate in capturing composite constructs (MacCallum and Browne 1993), no studies that I am aware of have used such an approach to model System Quality.

2.4 Service Quality

In organizations, the successful use or adoption of an IS often depends on the quality of service provided by IS department. Therefore, the quality of service has been examined extensively in many IS studies. In some studies the quality of service is measured by its back-end operational performance in producing, supplying, and utilizing data (e.g., Kriebel and Raviv 1980; Bailey and Pearson 1983). An even larger number of studies focused on the quality of front-end service relationships between service staffs and users (e.g., Ives, Olson et al. 1983; Baroudi and Orlikowski 1988; Teng, T C et al. 1995). To assess the quality of service, a group of measures of user attitude toward service staffs and their provided services were developed by Bailey et al. (1983) and Ives et al. (1984) However, these attitude measures had been criticized for the lack of clear definitions, consistency, update, and sufficient theoretical guidance (e.g., Doll and Torkzadeh 1988; Kettinger and Lee 1994).

More recently, IS researchers has adopted the SERVQUAL instrument, which is reputed to have established validity in marketing research. With this construct, researchers hoped to tap into the performance levels of the IS service function (e.g., Kettinger and Lee 1994; Pitt and Watson 1995; Kettinger and Lee 1997; Jiang, Klein et al. 2002; Cenfetelli, Benbasat et al. 2008). SERVQUAL has 22 items capturing five dimensions including tangible, reliability, responsiveness, assurance, and empathy of Service Quality as shown in Table 2-3 (Parasuraman, Zeithaml et al. 1988). Instead of being directly measured by these items, the Service Quality is reflected by the discrepancy between customer perceived Service Quality measures and customer expected Service Quality measures. (Parasuraman, Zeithaml et al. 1988, p. 14)

Table 2-3 SERVQUAL Dimensions (Parasuraman, Zeithaml et al. 1988)

Dimensions	Description
Tangibles	Physical facilities, equipment, and appearance of personnel
Reliability	Ability to perform the promised service dependably and accurately
Responsiveness	Willingness to help customers and provide prompt service
Assurance	Knowledge and courtesy of employees and their ability to inspire trust and confidence
Empathy	Caring, individualized attention the firm provides its customers

Despite its popularity in measuring Service Quality, SERVQUAL's five dimensional measurement has not gone unchallenged. Researchers in IS have often found that some of SERVQUAL dimensions did not hold up across different settings. The mixed empirical findings of SERVQUAL dimensional structure are summarized in Table 2-4.

Table 2-4 A List of Findings in Validating of SERVQUAL Dimensions

Authors	Method	Tangibles	Reliability	Responsiveness	Assurance	Empathy
Kettinger and Lee (1994)	Confirmatory factor analysis	☐	☑	☑	☑	☑
	Correlation analysis with user information satisfaction	☐	☑	☐	☐	☑
Kettinger and Lee (1995)	Exploratory factor analysis with Netherland sample	☐	☑	☑	☑	☑
	Exploratory factor analysis with Korean sample	☐	☑	☐	☐	☑
	Exploratory factor analysis with Hong Kong sample	☑	☐	☐	☐	☑
Pitt and Watson (1995)	Exploratory factor analysis with financial institution sample	☑	☐	☐	☐	☑
	Exploratory factor analysis with consulting firm sample	☑	☑	☐	☑	☑
	Exploratory factor analysis with information service business sample	☑	☑	☐	☐	☐
Jiang et al (2002)	Confirmatory analysis	Not tested	☑	☑	☑	☑

	Regression over user information satisfaction	Not tested	☑	☐	Wrong direction	☐
Kettinger and Lee (2005)	Exploratory factor analysis	☑	☑	☑	☐	☐

Researchers have also questioned the validity of using customer expectation as part of Service Quality discrepancy calculation due to the ambiguity inherent in customer expectations (e.g., Carman 1990; Cronin and Taylor 1992; Teas 1994; Dabholkar, Shepherd et al. 2000). Some researchers in IS believe that the complexity of user's psychological process in experiencing services would make discrepancy-based measurement less reliable than direct measures (Van Dyke and Kappelman 1997; Van Dyke, Prybutok et al. 1999). Others argue that such a concern has no empirical ground and the direct measurement approach can suffer higher measurement errors (e.g., Kettinger and Lee 1997; Pitt, Watson et al. 1997).

Regardless of the debate on the validity of SERVQUAL, Service Quality has been assumed theoretically to be a parallel key dimension along with Information Quality and System Quality in determining outcome variables such as the satisfactions of users with IS and their behavioral intention to use IS (e.g., Kettinger and Lee 1994; Pitt and Watson 1995). This line of thought has been particularly reflected in DeLone and McLean's 2003 ISM (relevant portion the model is shown in Figure 2-1). Nevertheless, the addition of this construct goes beyond the scope of their original application of information communication theory. In addition, very few extant IS studies have examined Service Quality in the presence of the original IS quality components of Information Quality and System Quality. Much more work is needed, therefore, in both better theorizing and more empirical testing to clarify the potential relationships among Information Quality, System Quality, and Service Quality as well as their relationships with other outcomes variables.

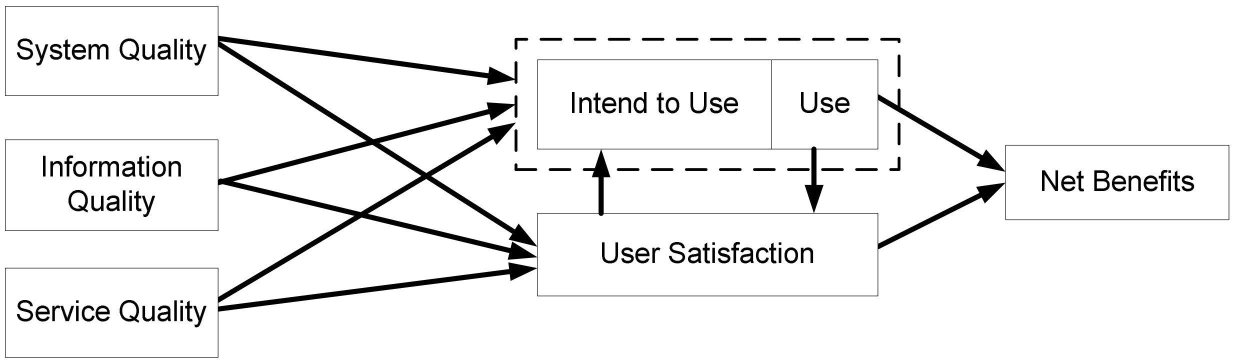

Figure 2-1 Upstream Linkages in the DeLone and McLean 2003 ISM

2.5 Theory and Hypotheses Development

2.5.1 Need an Updated View of Service Quality

Today, as many businesses go online, IT has become an important platform for service exchanges between companies and their customers. Most of front-end service activities of virtual businesses such as Amazon, eBay, and Google are conducted through the Internet. In these cases, "the explosively [sic] growing use of self-service technologies (SSTs)" (Rust and Kannan 2002, p. 13-14) has dramatically changed service models. Some of these business have built their service strategies "entirely around Internet access and delivery" (Lovelock and Wirtz 2004, p.8).

The use of IT in service not only changes the landscape of traditional service practices but also challenges our former conceptualization of service and Service Quality. Even the original authors of SERVQUAL realized the huge impact of Internet technologies on services and called for both conceptual and empirical research on the quality of service delivered over the Internet (e.g., Parasuraman and Zinkhan 2002; Zeithaml, Parasuraman et al. 2002). The original SERVQUAL dimensions with focus on human delivered services need to be reexamined, therefore, in order to help understand the quality aspects of services provided through IT. On the other hand, the obvious impacts of Information Quality and System Quality on customer-perceived Service Quality when a lot of service activities are enabled by IT imply that we need an updated examination of the relationships among Information Quality, System Quality, and Service Quality. More importantly, we need a consistent theoretical foundation that can guide our integration of IT quality aspects such as Information Quality and System Quality with the appropriate Service Quality dimensions including some of those established in SERVQUAL.

2.5.2 Exchanges in Services

To do this, we first need to clearly state what we mean by service. Service is an important research topic in the marketing literature (e.g., Rust and Kannan 2003; Lovelock and Wirtz 2004; Parasuraman, Zeithaml et al. 2005). A group of studies have identified a list of unique characteristics of service, features such as intangibility, heterogeneity, inseparability, and perishability, which implies the traditional quality management of physical goods might not apply to Service Quality management (e.g., Regan 1963; Lovelock 1980; Parasuraman, Zeithaml et al. 1985; Zeithaml, Parasuraman et al. 1990). Moreover, service is viewed as a dynamic process in which both providers and customers participate actively (Solomon, Surprenant et al. 1985; Shostack 1987). According to Gutek (1995, p. 1), "At the heart of service is a special kind of interaction between a customer and a provider of the service …" Typically, such an interaction or transaction involves the exchange of core benefits (e.g., physical goods, valuable information, or other deliverables for money) between a customer and a service provider (Cunningham 1980; Metcalf, Frear et al. 1993; Kalafatis 2002). Solomon et al (1985, p. 101) view these interactions as "a form of social exchange in which participants normally seek to maximize the rewards and minimize the cost of transaction." Such a view has its root in social exchange theory.

According to social exchange theory social exchange is considered as “a two-sided, mutually contingent, and mutually rewarding process involving ‘transactions’ or simply ‘exchange’ between two actors” (Emerson 1976, p. 336). The central unit of analysis in the theory is the longitudinal exchange relationship, which is developed and strengthened through a series of transactions between the same pair of actors. From this perspective, an actor’s behaviors should only be understood as the outcomes of the integral exchange relations with other actors. In particular, the pattern of the behavior is considered as the outcome of continuing reinforcement from other actors in their reciprocal exchange relation developed over time (Emerson 1976). The source of the reinforcement can be an actor’s resource, which is “an ability, possession, or other attribute of an actor giving him the capacity to reward (or punish) another specified actor” in relations (Emerson 1976, p. 347). An actor’s resource is only meaningful to other actors who have relations with him or her (Emerson 1976). Typically, the dyadic exchange relations can be connected with each other through a larger exchange networks (Molm 1991). Two exchange relationships are considered positively connected if one exchange relationship enhance the other and negatively connected if “one inhibits another” (Molm 1991, p. 476).

Traditionally, many studies of service focus on human person-to-person interactions (e.g., Solomon, Surprenant et al. 1985; Parasuraman, Zeithaml et al. 2005). When service view is confined to person-to-person interactions, “customer satisfaction and repeat patronage may be determined solely by the quality of the personal encounter” (Solomon, Surprenant et al. 1985, p. 107). In these cases, the attitude of service staff, personal relationship, communication, customer participation, etc. are considered as important indicators for Service Quality and satisfaction (e.g., Ives, Olson et al. 1983; Baroudi and Orlikowski 1988). The majority of the items in the SERVQUAL model also “relate directly to the human interaction element of service delivery”

(Bitner, Booms et al. 1990, p. 319). With various Internet-based information technologies (IT) such as knowledge bases, FAQs, live chat, etc. increasingly being used in services, IT plays an "important role in the delivery of services and goods" (Gutek 1995, p. 215). These technologies not only assist human agents in serving customers, but they can sometimes replace them entirely. In other words, part of functions and roles of human service providers can now be simulated by IT. On the other hand, customer expectations regarding service are also shaped by these new technologies (Rust and Kannan 2002). Considered together, we have a kind of simulated relationship between customers and IT. Such relationships can be considered as a form of "pseudo relationship" (Gutek 1995, p. 200). Here, IT is viewed as a pseudo service provider. We can easily extend the traditional social exchange view to consider those pseudo exchanges between customers and IT. This extension shares similarity with some early service conceptualization efforts of broadening customer interaction targets in a service to include "its personnel, its physical facilities, and other tangible elements" (Bitner 1990, p. 70; Shostack 1992). In those cases, the customer perceived service benefits "are wrought by the interactive aspect of services, both person-to-person and person-to-environment" (Otto and Ritchie 1995, p. 44).

Armed with this holistic service view, we first reconceptualize in the following section three key IS quality dimensions: Information Quality, System Quality, and Service Quality. Then, we examine how the extended pseudo exchange relations might be related to human exchange relations in various service scenarios. Following this, we discussion how these intertwined relationships of different exchange relations might reveal the potential causal links among three key IS quality constructs: Information Quality, System Quality, and Service Quality as well as their outcome variables such as User Satisfaction, Use / intention to use (see the following Figure 2-2).

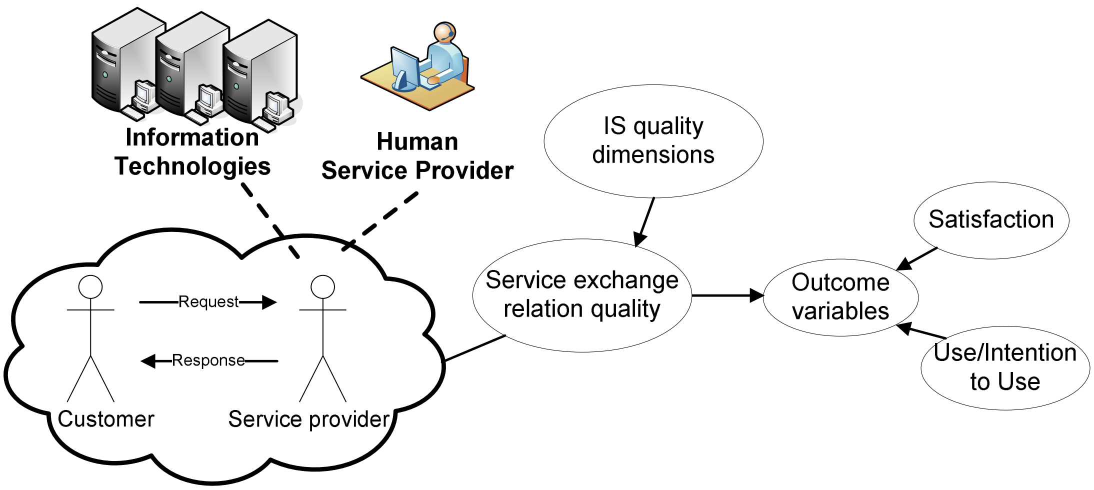

Figure 2-2 IS Quality Dimensions in Service Exchanges

2.5.3 Reconceptualizing Key IS Quality Concepts from a Service Exchange Perspective

In the IS literature, definitions of Information Quality, System Quality, and Service Quality have often been muddled and lack consistency or at best are "ill-defined" (Nelson, Todd et al. 2005, p. 201). For example, Ives and Olson (1984) define System Quality as "some aspect of the benefits [of] a system to the organization" (p. 591). Baroudi and Orlikowski (1988) define Information Quality as user assessment of "quality of output delivered by the information systems" (p. 48) and Service Quality as the user assessment of "the attitude and responsiveness of the EDP staff as well as the quality of their relationship with the EDP staff" (p. 48). Seddon (1997) defines Information Quality as "concerned with such issues as the relevance, timeliness, and accuracy of information generated by information systems" and System Quality as "concerned with whether or not there are 'bugs' in the system, the consistency of the user interface, ease of use, quality of documentation, and sometimes, quality and maintainability of the program code" (p. 246). Rai et al (2002) conceptualize System Quality as “the degree to which a system is user friendly” (p. 56) and Information Quality as “the degree in which IS generated information possess three attributes: content, accuracy, and format” (p. 56). Many of these conceptualizations are driven by empirical measures. Often they lack either consistency or completeness in representing the content domains of the corresponding constructs.

Here, by employing various service contexts from an exchange relational perspective, we reconceptualize these IS quality constructs: Information Quality, System Quality, and Service Quality.–In an exchange relationship, quality represents capability – a resource owned by one actor - service provider. To the other actor, the customer, good quality represents rewards that can reinforce his/her intention to engage continuous exchanges with the service provider. The service provider, here, can be a human actor or a pseudo actor such as IT that provides the services. From this perspective, Information Quality and System Quality are seen as resources owned by IT that can influence a customer’s intention to whether continue the exchange engagement. Those Service Quality dimensions captured by SERVQUAL can be viewed as resources owned by a human service provider that exert similar influence on a customer’s intention for future exchanges. With all this being said, we now proffer formal definitions of Information Quality, System Quality, and Service Quality as well as a clear statement of what we mean by service in the following:

- System Quality: *The capability of an IS artifact (IT) to process and deliver information for the benefit of users*
- Information Quality: *The capability of information output to benefit users*
- Service: *A series of interactions / exchanges between users and providers (human agents or IT) where the users benefit in both tangible and intangible ways*
- Service Quality: *The capability of a service to benefit users*

With these definitions, it is clear that we consider quality of IS to be a subjective matter. Although the quality of some individual components of an IS such as memory, hard drive, CPU speed, response time, etc. might be measured in an objective way, the quality dimensions such as Information Quality, System Quality, or Service Quality represent accumulated quality results that a user experiences through numerous interactions with an IS. On the user end, the objective measures rarely make sense if they do not match with the user experience. Therefore, we believe the definitions of quality constructs should be based on the user's evaluative judgment, which is subjective.

Next, we examine how human exchange and pseudo exchange might relate to each other under two primary service scenarios: intra-organizational IS services and external organizational online IS service. Through the discussions of these scenarios and their implications, we demonstrate how Service Quality, Information Quality, and System Quality can be related to each other.

2.5.4 IS Service Scenario I – Human Delivered IS Service

Traditionally one key function of an IS department is to provide various services to its users (Kettinger and Lee 1994). Studies of IS service often focus on the whole range of services provided by IS department (e.g., Kettinger and Lee 1994; Pitt and Watson 1995; Jiang, Klein et al. 2002). In this context, the possible heterogeneity of individual service staffs or systems within the department is often ignored. There is no distinct difference between individual service staff and service department since they are both treated as a homogenous unity that engages in the service exchange with customers. From the exchange perspective, the primary service exchanges occur between this unit and the customer. The customer might encounter one person or different staff members at different points throughout the service experience. Customer perceived service quality is based on his or her accumulated exchange experiences with the service unit. In

SERVQUAL “perceived quality is the consumer’s judgment about an entity’s overall excellence or superiority” (Zeithaml 1987; Parasuraman, Zeithaml et al. 1988, p. 15). On the other hand, the majority of customers served by IS department are also users of various computer technologies or applications such as ERP, Email, printer, Internet, etc. (Kettinger and Lee 1994). IS Services are often related to customer’s use of information technologies (IT) (as depicted in Figure 2-3). Applying our holistic service view, we can identify two kinds of service providers here. One is the human service staff providing services related to customer use of computer technologies. The other is IT used by users as pseudo service actor providing computing services related to user’s daily work (as shown in Figure 2-3). Figure 2-3 also indicates the dotted line connection between the human service provider and the IT. This would be the situation where the system is updated with new information/data or software by human service staff to serve user needs better.

Figure 2-3 Human Delivered IS Service

The traditional application of SERVQUAL in measuring IS Service Quality is often on person-to-person service and rarely considers the person-to-IT pseudo service (e.g., Kettinger and Lee 1994; Pitt and Watson 1995; Jiang, Klein et al. 2002). With this constrained view of IS service, Information Quality and System Quality are best considered to be on “the tangible end of the spectrum” and Service Quality is considered to be on “the other end of spectrum” in measuring IS success (Pitt and Watson 1995, p. 175). However, with our theoretical extension of service view to include concept of pseudo service, the traditional assumptions of the relationships among Information Quality, System Quality, and Service Quality need to be reexamined.

Depending on their organizational role and responsibilities, IS departments can provide a range of human-delivered services including information services and products, application development, training, maintenance, etc. (e.g., Bailey and Pearson 1983; Ives, Olson et al. 1983; Baroudi and Orlikowski 1988; Galleta and Lederer 1989). These are captured in Figure 2-4 by the lines of responses and requests interactions between the human service providers and customers. Some of these services such as training, FAQs, consultation, help desk, etc. are "directed at people's mind … and … affect customers in intangible ways" (Lovelock 1995, p. 70). Often, these services can help customers to "become comfortable with the system" especially "when an IS is first introduced" (Nelson and Cheney 1987, p. 548). On the other hand, the IT provides end-users information services "for their own analytical and reporting needs" (Benson 1983, p. 44). These are captured in Figure 2-4 by lines of the requests and output interactions between IT and customers. In these cases, a customer's expectation and experience of human delivered service are separate from his/her expectation and experience of IT pseudo service (as show by the solid lines in Figure 2-4).

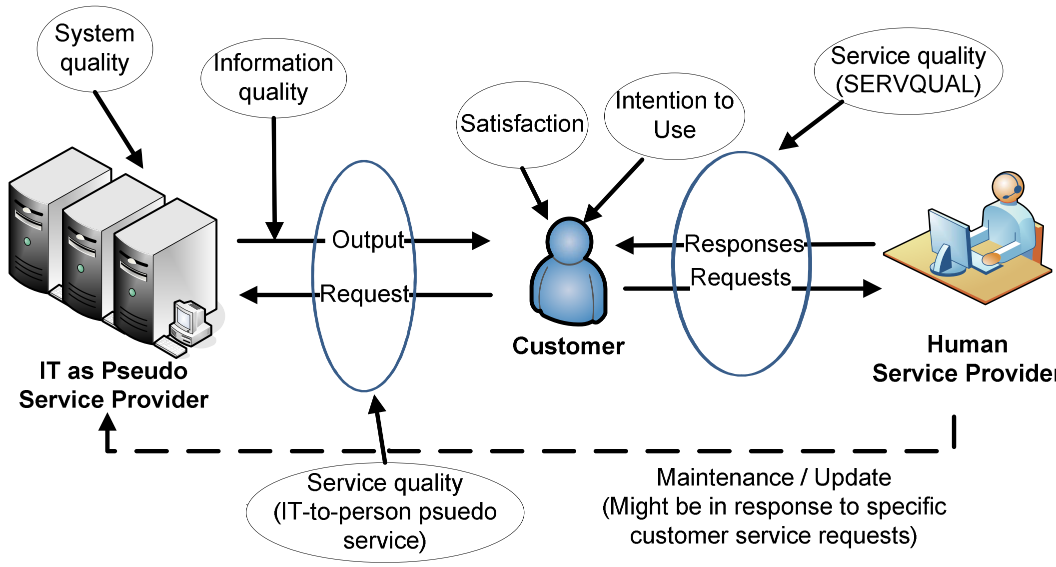

Figure 2-4 Human IS Service for End-user

Therefore, a customer's perceived quality of one service would not directly affect his or her perceived quality of information and system. These are captured by Figure 2-4, which shows a customer has separate interactions with IT and with the human service provider. Thus, we can conclude that human service quality dimensions as captured by SERVQUAL are independent from the IT pseudo service quality dimensions as captured by Information Quality and System Quality in determining IS Success outcome variables such as Use/Intention to Use, Satisfaction, etc. (DeLone and McLean 2003).

Services provided by IS department such as hardware installation, maintenance, telecommunication infrastructure, etc. focus on "tangible actions to physical objects to improve their value to customer … and … IT is assuming a greater role in delivery of the core service product … " (Lovelock 1995, p. 70). In these cases, customers "tend to be less involved in" person-to-person service interactions "because there is no real need for them to … accompany their possession while it is being processed" (Lovelock 1995, p. 70). What they finally receive out of those services would be the capable IT solutions providing computational services (functional and nonfunctional services) they need in their daily work. Obviously, the Information Quality and System Quality presented by those IT solutions would naturally be a part of a customer's perception of overall Service Quality (as shown by both solid and dashed lines in Figure 2-4) presented by IS department. Therefore, Information Quality and System Quality would have significant influence on customer perceived human service quality as captured by SERVQUAL dimensions.

A key function played by many IS departments is to provide information services such as data processing, application development, data communication, etc. (e.g., Wetherbe and Whitehead 1977; Benson 1983). Rather than focusing on the physical components of IT as with the hardware services discussed above, the IS information services focus on "intangible processing of inanimate objects …" and create value "by collecting, combining, analyzing, rearranging and interpreting information in useful ways" (Lovelock 1995, p. 71). In most cases, information outputs are delivered through IT to customers. The service provided by IT supplements human-delivered service. The customer perceived overall service quality would consist of his/her perceived quality of information and his/her experience of human delivered service quality.

Overall, we argue that traditional assumption of IS Service Quality, Information Quality, and System Quality being separate in providing contributions toward IS success might only hold when the human delivered service does not involve IT-delivered services (e.g., providing reports, processing queries, managing and sharing information, etc.) as the direct deliverable. In many cases, Information Quality and System Quality that a customer perceives through IT delivered pseudo service can influence his/her perception of human service quality.

2.5.5 IS Service Scenario II –Service Delivered Through IT

Internet businesses such as Amazon, Yahoo, and Ebay, etc. have used IT (mainly Internet-based technologies) as main service portal. Although Internet companies often provide customer service phone lines, there is a lack of physical presence for these businesses in general. Many front-end customer service activities such as providing product information, taking orders, taking customer inquiries, etc. are automated by various Internet technologies. Face-to-face interactions have been largely replaced by face-to-IT interactions through technologies such as interactive Web content, emails, online live chat, etc. Depending on the intelligence, computing power, and complexity of IT, some services (e.g., check-in, ATM, customer support, reservation, etc.) can be completely automated. For example, some companies compile and update a list of commonly asked questions from time to time and provide customers online FAQ service. Although this is a simple service, it saves service providers time and money by automating part of customer request handling process with database and dynamic Web technologies. For customers, this service saves time spent on waiting in lines to get answers from a human service representative. This is an example of self service where IT "enable a customer to produce and consume services without direct assistance from firm employees" (Ostrom, Bitner et al. 2002, p. 46). In self service, IT is capable to handle not just most front-end service interactions with customers but also back-end service processing. Person-to-person interactions are mostly replaced by person-to-IT interactions. Person-to-person interactions (shown as the dashed line in Figure 2-5) only occur when self services fail customer.

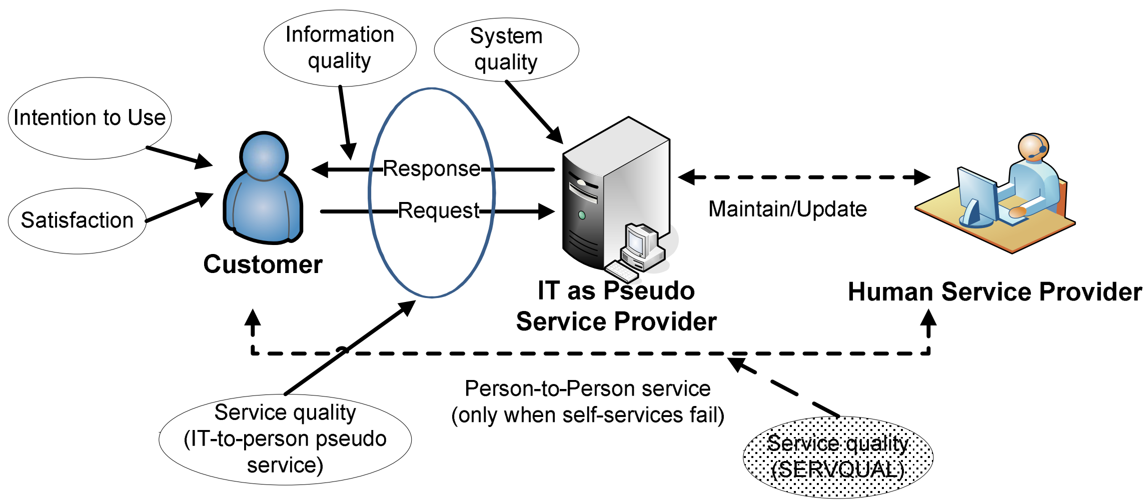

Figure 2-5 Quality Dimensions in Self Service

To customers, the Information Quality and System Quality that they experience in self services would be the major factors in shaping up their perceptions of overall service quality (as shown by the solid lines in Figure 2-5). Therefore, it is no surprise to see that self service quality measures developed in the marketing literature are dominated by Information Quality and System Quality measures such as reliability, ease to use, convenience, etc. (e.g., Parasuraman, Zeithaml et al. 2005; Collier and Bienstock 2006; Fassnacht and Koese 2006). In fact, some researchers have attempted to replace the original measures of SERVQUAL dimensions with those Information Quality and System Quality measures (e.g., Parasuraman, Zeithaml et al. 2005; Cenfetelli, Benbasat et al. 2008).

Although self-services are getting popular (Meuter, Ostrom et al. 2000; Ostrom, Bitner et al. 2002), many Internet-based businesses still require human intervention although part of the service process can automated by IT. In these businesses, the primary service contact that customers have with service providers is “through their Web sites on the Internet” (Hong, Tam et al. 2002, p. 108). IT such as E-mail, Live Chat, online discussion board, etc. are often used as both service tools and marketing channels that help Internet-based businesses such as Amazon, eBay, Google, etc. reach out to customers anywhere in the world (as shown in Figure 2-6). From service exchange perspective, IT is viewed as an important resource possessed by a service provider to add value such as convenience, efficiency, simplicity, etc. to existing services and make them more attractive to customers. The IT serves as the main channel that carries out the human-delivered services for customers (Gutek 1995). Compared with the traditional service model, IT channeled service interactions minimize the needs of face-to-face interactions between a customer and a human service agent, which could be expensive to maintain (e.g., requiring additional branches or staff, etc.). Certainly, the quality (Information Quality and System Quality) of the channel itself plays an important role in shaping customer experience of overall service quality (shown in Figure 9). The quality of service interactions between human service agent and customers is also important. In this case most SERVQUAL dimensions might be important part of overall service quality measures. However, the "tangible" dimension might lose its importance in measuring Service Quality. This is because typical customers rarely experience face-to-face interactions with service providers in those scenarios unless IT-mediated service channel fails (shown as the dash line in Figure 2-6).

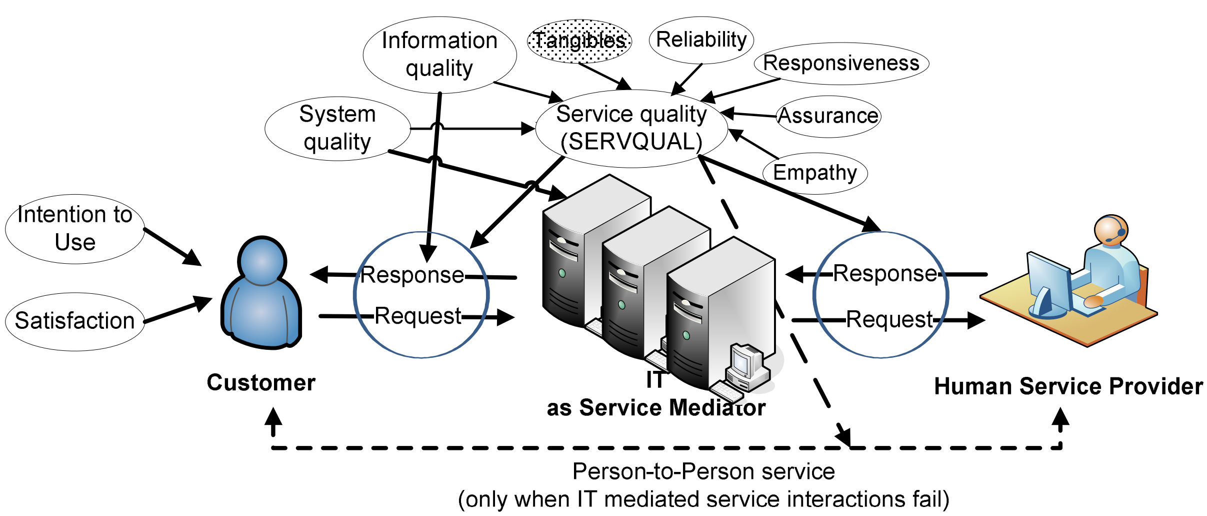

Figure 2-6 Quality Dimensions in IT mediated Service

2.5.6 **An Alternative IS Quality Model and Propositions**

The scenario analysis elaborated here is based on a marketing service exchange perspective. In applying it to DeLone and McLean's ISM, we propose alternative nomological linkages among three IS quality components, System Quality, Information Quality, and Service Quality, as well as new paths depicting their impact on the downstream constructs of Intention to Use, Use, and User Satisfaction (as shown in Figure 2-7). Clearly, the bulk of this model depends directly on DeLone and McLean's updated IS Success Model (2003), a model that has yet to be subjected to rigorous empirical testing in full scale. Thus, while DeLone and McLean (2003) propose that Service Quality will impact variables downstream including Intention to Use, Use and User Satisfaction, very few studies have tested these relationships (Petter and McLean 2006).

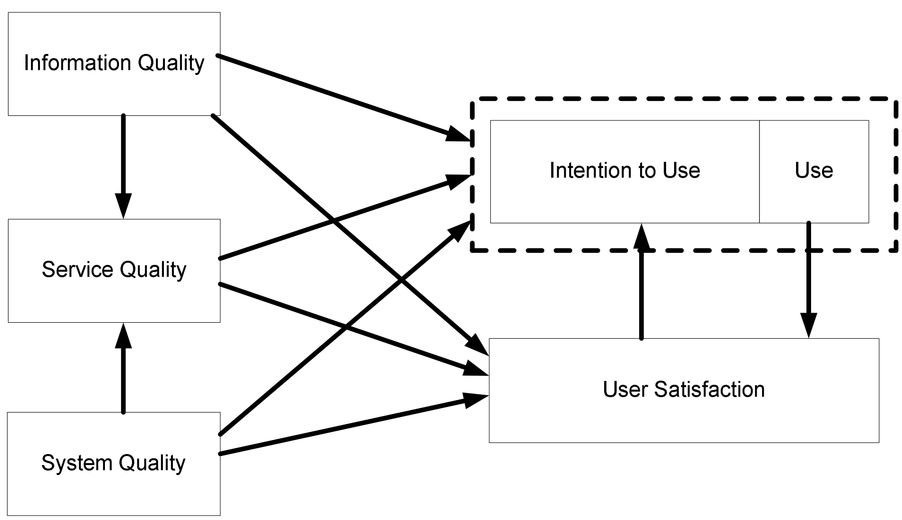

Figure 2-7 Theoretical Model of IS Quality

Based on this alternative IS quality model (Figure 2-7) and theoretical concepts, we state the following hypotheses for empirical testing:

H1: Service Quality partially mediates both the relationship between System Quality and Intention to Use/Use and the relationship between System Quality and User Satisfaction.

H2: Service Quality partially mediates both the relationship between Information Quality and intension use /Use and the relationship between Information Quality and User Satisfaction.

H3: Service Quality has a positive impact on Intention to Use /Use.

H4: Service Quality has a positive impact on User Satisfaction.

H5: Use has a positive impact on User Satisfaction.

H6: Satisfaction has a positive impact on Intention to Use

H7: Information Quality has a positive impact on Intention to Use/Use

H8: Information Quality has a positive impact on User Satisfaction

H9: System Quality has a positive impact on Intention to Use/Use

H10: System Quality has a positive impact on User Satisfaction

Considering the existing studies have shown the significant impacts of Information Quality and System Quality on IS success outcome variables such as User Satisfaction, Use, and Intention to Use, we keep those paths in our model for testing purpose.

2.5.7 **Summary**

Our next step is to tes our proposed alternative ISM empirically. The empirical study is conducted in two phases: (1) instrument development and validation and (2) theory-testing. During the first phase, our focus is on developing a valid instrument from existing measures of IS quality components. In particular, we start with content validity assessment of System Quality, Information Quality, and Service Quality constructs. Findings from this step provide input for further instrument development. Then, pilot tests are conducted to test measurement reliability and construct validities as well as instrument refinement. During the second phase, we conduct a full scale test on our reconceptualized IS quality model (shown Figure 2-7).

3. INSTRUMENT DEVELOPMENT

To test our proposed model, we need appropriate instruments to measure those constructs in the model. In the past, there are a number of instruments have been developed or applied to measure constructs of Information Quality, System Quality, and Service Quality individually (e.g., Zmud 1978; Moore and Benbasat 1991; Kettinger and Lee 1994). However, there is a lack of systematic effort in developing a general instrument that measures all three quality constructs together. For researchers and practitioners interested in the study of these constructs , such effort would be appreciated as it reduces their search cost by providing one stop shopping for measures of all three IS quality constructs at one place. Since there are no instruments in the literature that can really satisfy our measurement needs, we need to develop one for this study. To develop such an instrument, we need first "generate items which capture the domain as specified" (Churchill 1979, p. 67).

3.1 Initial Item Development

In this step, we need create "pools of items" for Information Quality, System Quality, and Service Quality either from "existing scales" or by creating "additional items" (Moore and Benbasat 1991, p. 198). Studies have used techniques such as interviews, observations, focus groups, etc. to create new measures for rarely examined or newly developed constructs (Bailey and Pearson 1983; Parasuraman, Zeithaml et al. 1988). Just as DeLone and McLean discovered in their 1992 study, the IS literature has numerous measures for measuring Information Quality, System Quality, and Service Quality. In this case, "selection of … items for a draft instrument from … literature simplifies instrument development" (Straub 1989, p.149). Therefore, given a variety of techniques available for item generation (e.g., Churchill 1979; Moore and Benbasat

1991; Straub, Boudreau et al. 2004), we selected and reused existing measures that fit our definitions of quality constructs; the means of doing this was through literature search rather than creating new items ourselves. Although DeLone and McLean conducted a comprehensive search of the IS literature and identified a list of existing measures for Information Quality and System Quality in their 1992 study, they did not empirically validate these measures. Without appropriate validation, the quality of a study using these measures could be at risk and “no single finding in the study [could] be trusted” (Straub 1989, p. 148). Still, with the 17 years of development of IS research and practice that have passed since DeLone and McLean (1992)’s study, an updated literature search for measures of Information Quality, System Quality, and Service Quality is needed.

Our literature search started with those highly ranked MIS journals, such as *MISQ*, *ISR*, *Decision Sciences*, *Management Science*, and *JMIS*. In particular, we selected articles published from 1985 to 2007 in those journals. Most articles were empirical studies that either developed their own instruments or reused existing instruments to measure one or at most two of the constructs of Information Quality, System Quality, and Service Quality. Through this massive literature search, we gathered a pool of items to be the basis of our initial instrument.

3.2 Content Validation

Our next step was to check the validity of these items through our instrument validation process since invalid measures remaining in an instrument could confound our consequent model testing. The validation of instruments should establish validities such as content validity, construct validity, predictive validity, reliability, manipulation validity, and statistical conclusion validity.

However, the instrument validation is never simple and easy (e.g., Nunnally 1978; Churchill 1979; Bagozzi and Phillips 1982; Trochim and Donnelly 2006).

Among these validities, content validity is usually the first one to be examined as it concerns whether the instrumentation generates representative measures of the content of a given construct (e.g., Straub 1989; Moore and Benbasat 1991). Content validity represents “adequacy with which a specified domain of content is sampled” (Nunnally 1978, p. 101). Content validity is “necessary for judging a measure as having reasonable construct validity” (Schriesheim, Powers et al. 1993, p. 386). Instruments lacking of content validity could fail to capture the correlations among measured constructs and lead to uncertain results (Schwab 1980; Straub 1989). Despite of its importance, in IS field only a limited number of studies have assessed content validity (23% - Boudreau, Gefen et al. 2001, p. 8).

For the establishment of content validity, there are a variety of appropriate techniques such as literature review, expert panels or judges, content validity ratios, Q-sorting, etc. (Straub, Boudreau et al. 2004, p. 385). In this study, we first develop a novel analysis method to examine the representativeness of each item in the IS literature for measuring Information Quality, System Quality, and Service Quality. Then, we apply expert panels for further content validation of our instrument. Through the first step, we attempted to refine our initial pool of items and eliminate those either outdated or inconsistent; they were deemed to be unfit for various reasons such as lack of theory guidance or prior validation. Such refinement also helped reduce the administrative cost of our second step which utilized expert panels. The refinement of content validity techniques is based on a consensus analysis of literature use of each item in the pool. Given its popularity and consistency in IS literature, each item was evaluated to whether it should be retained for further validation.

3.2.1 **Literature Consensus**

To evaluate the literature consensus on each item for measuring Information Quality, System Quality, and Service Quality, we applied a method originally developed by Lawshe (1975), one which was used to analyze judge panel consensus data. With this method, a statistics called "Content Validity Ratio" (CVR) determined the strength of the consensus. According to Lawshe (1975), CVR is calculated for an item as follows:

$$CVR = \frac{n_e - \frac{N}{2}}{\frac{N}{2}},$$

where n_e represents the number of panelists indicating an item is essential for measurement purpose, and N represents the total number of panelists. The scope of CVR ranges from -1.00 to +1.00. When CVR is less than 0, it indicates that the view that the item is indispensible is shared only by less than half of the panel. Moreover, the CVR of a measure needs to meet a minimum level according to the size of the panel (as shown in Table 3-1) so that the panel consensus is thought not to happen by chance (Lawshe 1975).

Table 3-1 Minimum Values of CVR with One Tailed Test, p = .05 from Lawsche (1975)

No. of Panelists	Min CVR
5 ~ 7	.99
8	.78
9	.75
10	.62
11	.59
12	.56
13	.54
14	.51
15	.49
20	.42
25	.37
30	.33
35	.31
40	.29

In our case, N represents the total number of IS studies that have either developed or applied a measure for IS quality dimensions, and n_e represents the number of studies that have a shared opinion on which IS quality dimension this measure represents. Following this formula, we calculated CVR for each item in the pool. In addition, a significance check with alpha=0.05 was applied for each CVR (an example is shown in the Table 2-1). All were found to be significant at this alpha level.

Table 3-2 Examples of Quality Measures With Literature Consensus Statistics

Measures	*Constructs*	*Number of Studies*	*CVR*
Relevance	Information Quality	11	.91
Timeline	Information Quality	14	.71
Accuracy	Information Quality	15	.76
Completeness	Information Quality	12	.83
Information Reliability	Information Quality	11	.72
Format	Information Quality	10	.89
… … …	… … …	… … …	… … …
Response Time	System Quality	15	.67
Ease of Use	System Quality	16	.75
System Reliability	System Quality	9	1
Efficiency	System Quality	9	.78
Accessibility	System Quality	11	.82
Flexibility	System Quality	10	.9
… … …	… … …	… … …	… … …
Empathy	Service Quality	10	.9
Responsiveness	Service Quality	12	.92
Tangibles	Service Quality	4	.5
Reliability	Service Quality	10	.9
Assurance	Service Quality	10	.8

3.2.2 **Results**

Based on this literature consensual analysis, we refined our initial pool of items for the instrument to 34 measures. Among them, we have 9 Information Quality measures, 8 System

Quality measures, and 17 Service Quality measures, all of which were derived from SERVQUAL. These measures formed a refined instrument for measuring Information Quality, System Quality, and Service Quality.

Our next step was to validate this draft instrument. Although we analyzed the literature in refining our initial list of IS quality measures, this alone was not sufficient for content validation in our view. With rapid progress in IT development and application, the IS contexts using these measures in the past might not reflect present IS contexts. Although some existing measures might still be reusable, their content validity needed to be reassessed under present IS contexts. Since the literature was silent as to providing updated evidence for content validity, we applied other approaches that seemed to be relevant. According to Straub (2004), "pretesting the instrument with … experts is highly advisable" (p. 387). With this approach, content validity is considered to be established "when an instrument "is judged by one or more persons as containing a reasonable and representative sample of items from the construct's theoretical domain (and when those judges do not see … extraneous items … from domains outside those of the theoretical construct)" (Schriesheim, Powers et al. 1993, p. 388).

3.2.3 **Method**

An expert panel approach has often been used "to rank how well the items fit the construct definitions" provided (Moore and Benbasat 1991, p. 199). There are a range of methods including both qualitative and quantitative approaches that can be applied. A qualitative approach that relies on a few experts' opinions has been criticized for its inherent small sample bias (Schriesheim, Powers et al. 1993). Quantitative approaches involve a range of techniques such as summary indices of panels' judgments, Q-sort, etc. (e.g., Stephenson 1953; Tucker 1966; Lawsche 1975; Morris and Fitz-Gibbon 1978). Some of these techniques such as Lawsche

(1975) 's content validity ratio lack "the ability to empirically determine the content dimensionality of a measure's items" (Schriesheim, Powers et al. 1993, p. 395). Other techniques such as Q-sort ignore the effect of individual differences among judges and can make the generalizability of results problematic (Gorsuch 1983; Cattell, Blaine et al. 1984). To get around these problems, Schriesheim et al. (1993) combined factor analysis of extended data matrices and the Q-methodology. In this study, we follow this approach to access the content validity of our instrument.

Besides finding an appropriate analysis method, we also needed to find at least one appropriate level which was also a contemporary IS context. In this study, our validation context centers on specific IS application rather than a system in general. This way minimizes possible inconsistencies among judges who might be reflecting on different application contexts when they make judgment about which items represents appropriate measures of Information Quality, System Quality, and Service Quality. Our chosen application in this study is a Web-based learning management system (LMS). It is used by a large southeastern U.S. university to manage online courses or complement classroom-based courses. The application was supported by IT department at the university. The support services were mostly online based via tools such as e-mail, live chat, FAQs, knowledge base, etc. The application itself provides a lot of service functions such as search, discussion board, calendar, document management, notes taking, progress management, etc.

This application enacts a typical IT-driven service context where most services activities are conducted either by or through information technologies (McKinney, Yoon et al. 2002). Not only can this context can be used for instrument validation but also for theoretical testing, as discussed in later sections.

Following Schriesheim et al. (1993), we first developed a rating form and administered it to a panel of expert judges. The judges we selected were doctoral students and faculty in IS since they had the "intellectual ability" to "read and understand" our rating tasks, items, and theoretical definitions of IS quality constructs (Schriesheim, Powers et al. 1993, p. 407). In addition, all of these judges were frequent users of the LMS. The rating form contained a section of instructions (as shown in Appendix B), with information regarding how respondents should complete the ratings. Definitions of service, Information Quality, System Quality, and Service Quality were listed on each page of the rating form to help clarify the concepts relationships to the rating contents. Examples were also provided to illustrate the rating mechanism.

Respondents were asked to "assign each item a score on each dimension being considered" (Schriesheim, Powers et al. 1993, p. 408). Our rating dimensions include Information Quality, System Quality, Service Quality, and other quality dimension. Definitions for "Information Quality," "System Quality," and "Service Quality" as discussed earlier in this dissertation were provided. A five point response scale was applied with 5=Completely, 4=Much, 3=Halfway, 2=Some, and 1=Not at all. In our pilot test, we have administered the questionnaire to 35 experts and received 27 usable responses.

3.2.4 **Analysis**

Schriesheim et al. (1993)'s approach to data analysis consists of two parts: a Q-factor analysis and a factor analysis of an extended matrix. Following this approach, we first consolidate the expert ratings of each item into a data matrix with rows representing content dimensions and columns representing items (as shown in the Table 3-3). We then conducted the Q-factor analysis of the combined expert ratings to determine whether our definitions of Information Quality, System Quality, and Service Quality were distinct enough to allow clear discrimination by judges. This also helps demonstrate whether classifications of Information Quality, System Quality, and Service Quality from the previous literature review were sufficient to represent all theoretical dimensionalities of the constructs.

Table 3-3 Example of Content Rating Means

	Item 1	Item 2	Item 3	Item 4	…
Information Quality	1.063	4.059	1.133	1.467	…
System Quality	1.688	2.063	1.667	4.500	…
Service Quality	4.294	2.625	4.500	3.200	…
Other Quality	1.400	1.667	1.357	1.286	…

In particular, a Q-correlation matrix (item by item) needed to be calculated and then subjected to a principal component analysis to extract four factors (Schriesheim, Powers et al. 1993, p. 400). Following this, a Varimax rotation was applied to achieve a100% explained variance. Finally, items were organized according to their loadings on Q-factors. Table 3-4 shows the Q-factor analysis results. It only lists positive and meaningful loadings. In this case, loadings of .40 or greater were considered meaningful (Ford, MacCallum et al. 1986). The result shows that items have meaningful loadings on three factors.

Table 3-4 Results of Q-Factor Loadings

Expected constructs and their items	*Factor 1*	*Factor 2*	*Factor 3*
Information Quality			
Currency	.998	---	---
Format	.955	---	---
Trustfulness	.967	---	---
Completeness	.992	---	---
Consistency	.993	---	---
Accuracy	.975	---	---
Understandability	.960	---	---
Usefulness	.977	---	---
Relevancy	.945	---	---
System Quality			
Reliability	---	.952	---
Accessibility	---	.970	---

Flexibility	---	.761	.604
Entertainment	---	.436	---
Sophistication	---	.702	.771
Response time	---	.958	---
Integration	---	.872	---
Ease of use	---	.965	---
Service Quality (SERVQUAL)			
Convenient operation hours	---	---	.979
Perform service right	---	---	.984
Has user interest in heart	---	---	.997
Keep user updated	---	---	.988
Willingness to help	---	---	.999
Capability to do what is promised by certain time	---	---	.995
Knowledge to do job well	---	---	.991
Up-to-date facilities	---	.885	---
Visually appealing facilities	---	---	---
Dressing and appearance	---	---	---
Sincere interest toward problem solving	---	---	.981
Capability to maintain a full functional system	---	.595	.785
Responsiveness to user requests	---	---	.994
Capability to keep user information safe	---	.618	.778
Consistent courteousness	---	---	.981
Capability to give user individual attention	---	---	.994
Capability to understand user needs	---	---	.999

It is obvious that the first factor is Information Quality. There are nine items that loaded on this factor. All these items were previously identified as measures of the Information Quality in the IS literature. None of these items had any meaningful loadings on other factors. Therefore, we conclude factor 1 represents Information Quality.

For the second factor, there are eleven items that have meaningful loadings on this factor. Among them, eight are identified as measures of System Quality in the previous literature review. Their loadings range from .436 to .970. Two items "Flexibility" and "Sophistication" cross-load onto factor 3. In particular, the item "Sophistication" seems to be more related to factor 3 than factor 2. Three SERVQUAL items also have significant loadings on this factor. Since the majority of items loading on this factor are System Quality measures as identified in the literature, we can readily conclude that factor 2 represents System Quality.

On factor 3, sixteen items have meaningful loadings. Among these items, fourteen are SERVQUAL measures. Two are System Quality measures (as discussed above). The loadings on factor 3 clearly show that factor 3 represents Service Quality in that fourteen out of seventeen SERVQUAL items loaded on this factor and have no meaningful loadings on other factors.

Two SERVQUAL items: "visually appealing facilities" and "dress and appearance" failed to load on any factor. Both of them, however, had the highest mean judge ratings in the category of "Other Quality." Notably, these ratings (both at 2.625) fall around the middle of importance spectrum from completely unimportant to very important. This suggests that the judges were not sure about their importance in representing any quality dimension in this learning context. This result is consistent with findings in other studies that have applied confirmatory factor analysis to validate the dimensional structure of SERVQUAL. That is, the original "tangible" dimension of SERVQUAL often does not hold as a dimension in studies of IS services (e.g., Kettinger and Lee 1994; Pitt and Watson 1995).

Overall, this Q-factor analysis demonstrates that most items in the initial pool have retained the content validity and still represent their corresponding constructs. However, according to

Schriesheim et al. (1993), Q-factor analysis alone has limitations in sufficiently demonstrating content validity. This is because Q- factor analysis is conducted on the collapsed values of individual judge ratings, that is, mean ratings, where individual effects are necessarily ignored.

To investigate whether the individual differences might have an impact on the final result, he suggested complementing the Q-factor analysis with a factor analysis of the extended data matrix. This extended data matrix is constructed with the ratings of a panel of size N for each of M items on a continuous scale "for each K content dimensions separately" (Schriesheim, Powers et al. 1993, p. 397). Following this suggestion, we developed our own extended data matrix (an example is shown in Table 3-5).

Table 3-5 Example of Extended Data Matrix

	Quality Dimension	***Item1***	***Item2***	***Item3***	**…**
Judge 1	Information Quality	1.00	4.00	1.00	…
Judge 1	System Quality	3.00	1.00	2.00	…
Judge 1	Service Quality	4.00	4.00	4.00	…
Judge 1	Other Quality	1.00	1.00	1.00	…
Judge 2	Information Quality	1.00	3.00	1.00	…
Judge 2	System Quality	2.00	3.00	2.00	…
Judge 2	Service Quality	5.00	2.00	4.00	…
Judge 2	Other Quality	1.00	1.00	1.00	…
Judge 3	Information Quality	1.00	4.00	1.00	…
Judge 3	System Quality	1.00	2.00	3.00	…
Judge 3	Service Quality	5.00	5.00	5.00	…
Judge 3	Other Quality	1.00	2.00	1.00	…
…	…	…	…	…	…

In this matrix, each judge had 4 rows of item ratings against dimensions such as Information Quality, System Quality, Service Quality, and other quality. The item correlations are calculated across judges and dimensions. Then, we apply principal axis factor analysis to extract 3 factors with a Varimax rotation. Attempting to extract 4 or more factors doesn't yield a different factor structure. We applied the same criteria used in the Q-factor analysis to determine meaningful item loadings. Meaningful item loadings are listed in the Table 3-6.

Table 3-6 Item Loadings of Extended Matrix Factor Analysis

	Factor 1	***Factor 2***	***Factor 3***
Information Quality			
Currency	.831	---	---
Format	.792	---	---
Trustfulness	.765	---	---
Completeness	.873	---	---
Consistency	.834	---	---
Accuracy	.919	---	---
Understandability	.920	---	---
Usefulness	.916	---	---
Relevancy	.921	---	---
System Quality			
Reliability	---	.789	---
Accessibility	---	.763	---
Flexibility	---	.653	.407
Entertainment	---	.475	---
Sophistication	---	.583	---
Response time	---	.884	---
Integration	---	.645	---
Ease of use	---	.820	---
Service Quality			
Convenient operation hours	---	---	.918
Perform service right	---	---	.916
Has user interest in heart	---	---	.912
Keep user updated	---	---	.899
Willingness to help	---	---	.957
Capability to do what is promised by certain time	---	---	.968
Knowledge to do job well	---	---	.973
Up-to-date facilities	---	.826	---
Visually appealing facilities	---	---	---
Dressing and appearance	---	---	---
Sincere interest toward problem solving	---	---	.897
Capability to maintain a	---	.502	.686

full functional system			
Responsiveness to user requests	---	---	.958
Capability to keep user information safe	---	---	.528
Consistent courteousness	---	---	.835
Capability to give user individual attention	---	---	.967
Capability to understand user needs	---	---	.944

The item loadings from this analysis do not differ much from the item loadings in the original Q-factor analysis. For the first factor, the extended matrix factor analysis shares the similar pattern as Q-factor analysis. It obviously represents Information Quality as all nine items loaded well with a loading range from .765 to .921. For the second factor, there are ten items that have a meaningful loading with a range from .475 to .884. All eight items used to measure System Quality in the literature have a meaning loading on this factor. One of them “flexibility” had a cross loading on the third factor. Yet, this cross loading (0.407) is still less than its loading (.653) on the second factor. In addition, two SERVQUAL items “Up-to-date facilities” and “Capability to maintain a full functional system” also have meaningful loadings on this factor. Among them, the “Up-to-date facilities” SERVQUAL item only loads on the second factor meaningfully. The “Capability to maintain a full functional system” SERVQUAL item has a higher loading (.686) on the third factor than its loading (.502) on the second factor. Since the majority of items loaded on the second factor are measures of System Quality in the literature, it can be concluded that this second factor represents System Quality. The additional loadings from two SERVQUAL items on this factor also confirm our belief that the content meanings of quality measures used to represent in the traditional contexts could change in IT-enabled service context due to the intertwinement of IT-delivered and human-delivered services.

Comparing this matrix to the results of Q-factor analysis shows that items of System Quality selected from the literature are more consistent in their loadings on this factor. For the third factor, we have fourteen SERVQUAL items that load on this factor. One of them "Capability to maintain a full functional system" has a cross loading on the second factor. But its cross loading (.502) is less than its loading (.686) on the third factor. In addition, "Flexibility," an item used to measure System Quality in the literature, also has a meaningful loading on the third factor. Since majority of the items loaded on this factor are SERVQUAL items, we can conclude that this factor represents the Service Quality. The loading from a System Quality item "Flexibility" on this factor can be considered as a consequence of the context change from tradition IS contexts to IT driven service context.

Overall, our analysis has largely demonstrated (i.e., 100% on selected Information Quality measures, around 75% on selected System Quality measures, and around 81% on selected Service Quality measures) our experts have agreed with the literature on those items used for measuring Information Quality, System Quality, and Service Quality.

3.2.5 Content Validation Outcome

Overall, our result suggests that the traditional classification of IS quality dimensions into System Quality, Information Quality, and Service Quality (e.g., DeLone and McLean 1992; Pitt and Watson 1995; DeLone and McLean 2003) are "meaningful" in the online service context and our definitions of these constructs are clear enough to allow judges to discriminate among those dimensions (Schriesheim, Powers et al. 1993, p. 405). The result also shows that our initial instrument developed from literature review needed some refinement in order to be content valid since it still contained misclassified item such as "Up-to-date facilities" and confounding items that captured both System Quality and Service Quality (e.g., "flexibility," "sophistication," “capability” to maintain a full functional system,” etc.). To do so, we need to “reassign the misassigned items to their proper dimensions” and “omit the items” which measure multiple IS quality dimensions (Schriesheim, Powers et al. 1993, p. 404). Finally, through our validation process, we generate a list of 29 content validated items for our draft instrument.

3.3 Construct Validation

Still, valid content in an instrument does not guarantee construct validity, “which lies at the very heart of the scientific process, is most directly related to the question of what the instrument is in fact measuring – what construct, trait, or concept …” (Churchill 1979, p. 70). An instrument without appropriate construct validation can lead to “biased and inconsistent … estimates of causal parameters” in the testing of theory (Bagozzi and Phillips 1982, p. 460).

Construct validity concerns how well an item behaves in operationalizing a given construct according to its relationship with this construct (Trochim and Donnelly 2006). In general, there are two kinds of measurement models that specify the causal relation between items - “observable variables or indicators” and their constructs - latent and unobservable variables (Anderson and Gerbing 1982, p. 453). One is the reflective measurement model, which is commonly assumed in the traditional factor analysis and classical test theory (e.g., Fornell and Bookstein 1982; Greenberg 2003). It specifies a construct causes the common variance shared by its observable indicators (Fornell and Bookstein 1982). The other is the formative model. It specifies “the creation or change” in a construct is caused or formed by its observable indicators (Chin 1998, p. ix). Since “the choice between formative and reflective models” can “substantially affects” construct validation and the following model “estimation procedures”

(Fornell and Bookstein 1982, p. 441) we need first select the appropriate measurement models for our key theoretical constructs of Information Quality, System Quality, and Service Quality.

As we have discussed in previous sections, in IS literature different measurement models have been applied for constructs of Information Quality and System Quality (as shown in Table 3-7 and Table 3-8).

Table 3-7 Examples of Information Quality Measurement Models Used in IS Studies

Authors	Measures	Dimensions of Information Quality	Latent Model
Gallagher (1974)	Completeness, readability, currency, valid, …	Quantity, format, reliability, timeline	Multi-dimensional
Zmud (1978)	Relevant, accurate, precise, …	Information, relevancy, format	Multi-dimensional
Ives et al (1983)	Currency, reliability, relevancy, …	N/A	Unidimensional
Swanson (1987)	Accurate, comprehensive, precise, reliable, timely, …	N/A	Unidimensional
Baroudi and Orlikowski (1988)	Reliability, relevancy, accuracy, precision, …	N/A	Unidimensional
Kettinger and Lee (1994)	Reliability, relevancy, accuracy, precision, …	N/A	Unidimensional
Teng et al (1995)	Reliability, relevancy, accuracy, completeness, …	N/A	Unidimensional
Rai et al (2002)	Precise, exact, sufficient, helpful, number of errors, …	N/A	Unidimensional
McKinney et al (2002)	Applicable, current, believable, instrumental, …	Relevance, timeliness, reliability, usefulness	Multi-dimensional
Wixom and Todd (2005)	Comprehensive, correct, well laid out,	Completeness, accuracy, format, currency	Multi-dimensional

	most recent, …		
Nelson et al. (2005)	Comprehensive, few errors, clearly presented, current, …	Completeness, accuracy, format, currency	Multi-dimensional

Table 3-8 Examples of System Quality Measurement Models Used in IS Studies

Authors	Measures	Dimensions of System Quality	Latent Model
Wixom and Watson (2001)	Flexibility, integration, versatility, …	N/A	Unidimensional
Rai et al (2002)	Ease of Use, …	N/A	Unidimensional
Chen and Hitt (2002)	Summary measurement of system quality, …	N/A	Unidimensional
McKinney et al (2002)	Responsive, easy to use, easy to locate, search engine, …	Access, usability, navigation, interactivity	Multi-dimensional
Wixom and Todd (2005)	Operation reliability, easy to access, flexibly adjust to new demands, effective data combination, …	Reliability, flexibility, integration, accessibility, timeliness	Multi-dimensional
Nelson et al. (2005)	Operation reliability, flexibility to adjust, effectively combine data, easy to access, not too long to respond, …	Reliability, flexibility, integration, accessibility, response time	Multi-dimensional

From an exchange perspective, we see quality as a valuable capability/resource possessed by a business through their products or services to attract their customers into the continuous business exchanges with them. The quality of a product or a service is only valuable when the customers perceive it to be during the business exchanges. Such perceptions are "largely attribute-based," "thought to be primarily cognitive," and based on “many different product cues … to infer quality …” (Oliver 1997, p. 178 - 179). In the IS literature, quality constructs such as Information Quality and System Quality are typically evaluated based on customer/user assessments of individual attributes of a product or a service such as information and system. Although attributes such as flexibility, relevancy, accuracy, etc. look distinct from each other, IS studies often treat them as equivalently exchangeable concepts by modeling them as reflective indicators of constructs such as Information Quality and System Quality. The conceptual implication of a reflective measurement model implies that an increase in a latent variable leads to simultaneous increases among its reflective indicators (Bollen and Lennox 1991). However, for the concept of quality, this should be the opposite. That is an increase of customer/user perceptions of individual indictors such as flexibility, relevancy, accuracy, etc. should lead to an increase in overall customer/user quality perception because such perceptions are typically derived “from the cumulative experience” of these distinct attributes (Oliver 1997, p. 176). That is to say, quality constructs as typically measured should be formative. Jarvis et al. (2003) have proposed four rules for determining whether a construct should be reflectively or formatively related with its measures. The first rule is based on an examination of “the theoretical direction of causality between each construct and its measures” (Petter, Straub et al. 2007, p. 622). That is if a change in a measure causes a change in its construct in the same direction, then this measure would be a formative measure of its construct. On the contrary, if a measure is a manifestation of its construct then it should be considered as a reflective measure of its construct. Applying this rule to examine the causality between common quality measures such as flexibility, relevancy, accuracy, etc. and their quality constructs such as Information Quality and System Quality, we can easily find that a change in any of these quality measures would lead to a change in the overall quality construct. However, a change (e.g., increase) of the overall quality construct does not necessarily reflect a change (e.g., increase) of individual quality characteristics. For example, an improvement of overall Information Quality might be caused by an improvement of format even though other Information Quality aspects such as accuracy, relevancy, etc. still remain the same.

The second rule proposed by Jarvis et al. (2003) is based on an examination of interchangeability of related measures. That is if all measures of a construct are “interchangeable and have a common theme” they are considered as reflective measures of a construct (Petter, Straub et al. 2007, p. 622). Otherwise, they should be treated as formative measures. Applying this rule to examine the interchangeability of Information Quality or System Quality measures such as flexibility, relevancy, accuracy, etc., one would have to conclude that these are not interchangeable. A system can be flexible without being accurate, etc.

The third rule of Jarvis et al. (2003) is based on a statistical examination of the strength that one measure covary with other related measures in measuring a construct. For reflective measures, they should be strongly correlated. For formative measures, strong correlation suggests multicollinearity, which can “destabilize the construct” (Petter, Straub et al. 2007, p. 634). Since the application of this rule requires empirical data, it is really not relevant at at this point. Theoretical considerations should dominate the discussion now. However, it is discussed in the later part of the study when the empirical data is gathered and analyzed.

The last rule proposed by Jarvis et al. (2003) is to check if the measures of the construct share the “same antecedents and consequences” (Petter, Straub et al. 2007, p. 634). For formative measures, their antecedents and consequences can be very different. For example, the indicators of System Quality such as reliability, accessibility, flexibility, etc. might not share the same antecedents and consequences. What cause the change in reliability might not be the same causes of the change in flexibility. On the other hand, an improvement of system flexibility might improve the operating efficiency (Gebauer and Schober 2006). An improvement of system reliability might lead to different consequences such as improving the system safety (Rausand

and Hyland 2004). For reflective measures, because they are the manifestation of the construct they usually share the same antecedents and consequences. Although quality measures such as reliability, format, accuracy, etc. might be used to measure common variables such as satisfaction, it is not unreasonable to see that they have been used to measure different constructs such as capability, value, attitude, etc. as we discussed previously (e.g., Gallagher 1974; Schewe 1976; Hamilton and Chervany 1981).

Some IS studies have applied multi-dimensional models to operationalize the constructs of Information Quality and System Quality (as shown in Table 3-7 and Table 3-8). With multi-dimensional models, the constructs of Information Quality and System Quality are modeled as second-order constructs that are measured by their first-order dimensions, which themselves are also latent variables measured by their corresponding observable indicators. Depending on the relations between the overall construct and its sub-dimensions, a multi-dimensional model can be modeled either formatively or reflectively with its first-order dimensions. Law et al. (1998, p. 743) has classified three different multidimensional models: “latent model,” “profile model,” and “aggregate model.” Among them, the latent model represents a multi-dimensional model with its second-order construct measured by its first-order reflective dimensions. Both the profile model and the aggregate model specify a formative approach to measure a second-order construct with its first-order dimensions being either linear or nonlinear. To measure Information Quality and System Quality, some IS studies have chosen a latent model (e.g., McKinney, Yoon et al. 2002). We argue that this approach suffers the same weaknesses of the first-order only reflective model, which ignores the distinctiveness among typical Information Quality or System Quality attributes.

Other IS studies (e.g., Nelson, Todd et al. 2005; Wixom and Todd 2005) have applied an aggregate model with “reflective first-order” and “formative second-order” in an attempt to capture distinct attributes of Information Quality and System Quality (Jarvis, Mackenzie et al. 2003, p. 741). Although this approach does follow a formative approach and could have “substantial advantage of incorporating measurement error” compared with a single level formative measurement model, conceptual justification for using multiple first-order dimensions could be questionable (Diamantopoulos, Riefler et al. 2008, p. 1211).

For constructs like Information Quality, “there is little consensus on what constitutes a complete and yet parsimonious set of Information Quality dimensions” (Nelson, Todd et al. 2005, p. 203). For System Quality, “there is even less formal treatment” in the existing IS literature (Nelson, Todd et al. 2005, p. 205). Without appropriate and theoretical justification, the introduction of first-order dimensions could “adversely affect model parsimony” and also suggest that these first-order dimensions “can more or less automatically be specified” for any empirically derived set of manifest variables (Diamantopoulos, Riefler et al. 2008, p. 1211).

Since the focus of our study here is not on theorizing the sub-dimensions of Information Quality and System Quality, a multi-dimensional measurement model would be a hard to justify choice. Therefore, we treat quality attributes like accuracy, reliability, completeness, relevancy, etc. as observable formative indicators rather than as latent first-order dimensions of Information Quality and System Quality. From a practice perspective, this is also desirable because treating those attributes as latent dimensions would make it difficult not only for data collection when more measures are required but also for later structural model testing when more parameters need to be estimated (Diamantopoulos and Winklhofer 2001).

As we have discussed in the previous sections, Service Quality in IS literature is typically measured with SERVQUAL, a multi-dimensional construct. Some studies using SERVQUAL (e.g., Kettinger and Lee 1994; Jiang, Klein et al. 2002) have chosen a latent multi-dimensional model and a few have applied an aggregate multi-dimensional model (e.g., Carr 2007). Choosing such a model to measure Service Quality implies its first-order dimensions are interchangeable and the removal of any first order dimension would not change "the essential nature of the underlying construct." However, customer perceived service quality conceptually is considered to be a kind of "attitude" that is based on a customer's evaluations along a list of attributes or "characteristics the service and its provider should possess" (Parasuraman, Zeithaml et al. 1988, p. 15-16). In the literature, there is also a shared understanding that the Service Quality construct consists of multiple "distinct dimensions" (Bitner 1990; Zeithaml, Parasuraman et al. 1990, p. 26; Bitner and Hubbert 1994; Cronin and Taylor 1994; Parasuraman, Zeithaml et al. 1994). Obviously, a latent multi-dimensional model would ignore such shared understanding that Service Quality sub-dimensions are distinct from each other. Therefore, in this study, we choose a formative model to measure Service Quality, which implies that missing any indicator "is omitting a part of the construct" (Bollen and Lennox 1991, p. 308) . Likewise in this study, we choose an aggregate multi-dimensional model to operationalize the construct of Service Quality, given that our measures are mainly derived from SERVQUAL.

Since our key constructs of Information Quality, System Quality, and Service Quality are all measured via a formative approach, "conventional procedures used to assess the validity and reliability of … reflective indicators (e.g., factor analysis and assessment of internal consistency) are not appropriate for … formative indicators" (Diamantopoulos and Winklhofer 2001, p. 271). For reflective measures, discriminant validity and convergent validity are typically assessed in the construct validation (e.g., Campbell and Fiske 1959; Churchill 1979; Straub 1989). Discriminant validity represents "the degree to which measures" reflecting "distinct constructs differ" (Bagozzi and Phillips 1982, p. 469). The discriminant validity of a reflective measure can be established if this measure is not significantly correlated with measures of different constructs (Trochim and Donnelly 2006). The convergent validity of a reflective measure can be demonstrated by "the extent to which it correlates highly with other methods designed to measure the same construct" (Churchill 1979, p. 70).

For formative measures, the discriminant validity and convergent validity in item correlation sense are barely meaningful since "a change in an indicator … does not necessarily imply a similar directional change for the other indicators …" (Chin 1998, p. ix). Therefore, in those cases the magnitude of the item correlations does not tell much about "the validity of an item as a measure of a construct" (Bollen and Lennox 1991, p. 307). In fact, the high correlations among formative measures of the same construct could create a multicollinearity problem, which makes it "difficult to separate the distinct impact" of individual formative measures on a given construct (Bollen and Lennox 1991, p. 307).

In addition to convergent validity and discriminant validity, other validities such as unidimensionality and nomological validity have also been assessed in a number of studies for establishing the construct validity (e.g., Segars 1997; Gefen 2003; Straub, Boudreau et al. 2004). A reflective measure demonstrates sufficient unidimensionality if its error variance is not shared or significantly correlated with error variances of other measures (e.g., Gerbing and Anderson 1988; Gefen 2003). Again, for formative measures this correlation-based unidimensionality assessment approach does not apply.

Nomological validity has gained more ground in IS studies during recent years. It concerns the validity of a measure in fitting a given construct that it intends to measure into its own nomological network, which consists of "the interlocking system of laws that constitute a theory" (Cronbach and Meehl 1955, p.290). Specifically, the nomological validity of a reflective or formative measure can be established if it links the construct it intends to measure "to other constructs with which it would be expected to be linked (i.e., antecedents and/or consequences)" (Diamantopoulos and Winklhofer 2001, p. 273).

In the IS literature, there are numerous studies that have found empirical evidence showing the influence of Information Quality, System Quality, and Service Quality on User Satisfaction (e.g., Baroudi and Orlikowski 1988; Doll and Torkzadeh 1988; Kettinger and Lee 1994; Rai, Lang et al. 2002). Therefore, the nomological network of these IS quality constructs (e.g., Information Quality and System Quality) can be depicted via the model shown in Figure 3-1. A test of this model would help us assess the nomological validity of our instrument. That is, if our instrument is nomological valid, this model should be empirically supported by a test with our IS quality instrument.

Overall, unlike the development of methods for validating the reflective measures, the development of methodologies to validate formative measures has been rather limited (e.g., Petter, Straub et al. 2007; Cenfetelli and Bassellier 2009; Diamantopoulos and Siguaw 2009). Some studies have discussed a need of checking indicator collinearity, reliability, or external validity as part of measurement validity assessment (e.g., Diamantopoulos and Winklhofer 2001; Jarvis, Mackenzie et al. 2003; Petter, Straub et al. 2007). Others have developed alternative ways of testing the convergent validity and discriminant validity of formative measures based on "a variation of Campbell and Fiske's multitrait-multimethod (MTMM) analysis" (Loch, Straub et al. 2003, p. 48-49). In this study, some of these methods are deployed for construct validation.

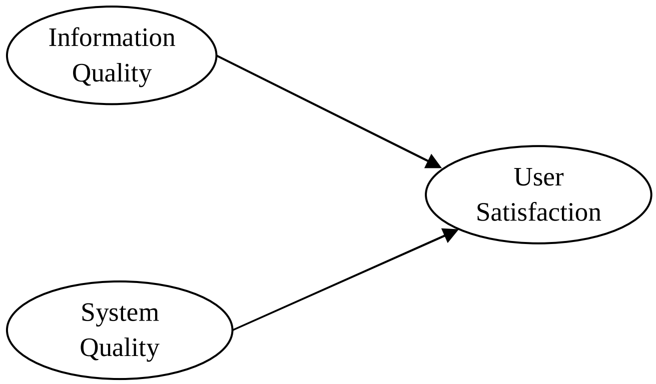

Figure 3-1 Nomological Network Model

3.4 Method

Today, with structural equation modeling techniques (SEM) such as covariance-based applications such as LISREL and components-based ones such as PLS, the measurement models can be tested along with structural models. Therefore, our construct validation is conducted through the test of the model in Figure 2-7. To test this model, we choose a questionnaire-based field study approach to collect data. Since the model in Figure 3-1 is a simplified version of the overall model shown in Figure 2-7, a single data collection for the test of the overall model would also serve the data needs for the test of the simplified model in Figure 3-1.

Our questionnaire development involved gathering measures of Information Quality, System Quality, and Service Quality by means of a questionnaire validated for content by a variety of techniques. In addition to those measures, for model identification purposes, we also adopted three global measures for each of Information Quality, System Quality, and Service Quality as reflective indicators from existing studies (e.g., Nelson, Todd et al. 2005; Wixom and Todd

2005). For those aforementioned quality constructs' measurement, the seven level Likert response scale ranging from "Strongly disagree" to "Strongly agree" was used.

The measurement of constructs such as Intention to Use and System Use have been discussed in a number of IS studies (e.g., Davis, Bagozzi et al. 1992; Jackson, Chow et al. 1997; DeLone and McLean 2003; Bhattacherjee and Premkumar 2004; Barki, Titah et al. 2007). The measurement of System Use often tends to be superficial and lack systematic theoretical mapping (DeLone and McLean 2003). Burton-Jones and Straub (2006) have suggested a systematic approach to help researchers develop rich measures based on its nomological network and the theoretical and practical contexts of System Use to capture its complexity. A rich measure involves interactions of three relevant elements (i.e., system, user, and task).

The practical context in which the System Use is studied is based on a Web-based Learning Management Systems (LMS) maintained by the university IS department which provides a variety of online services such as mailing, group discussing, virtual meeting, class scheduling, study material managing, etc. These services are offered through a number of system functional features such as email, discussion board, chat and whiteboard, calendar tool, file manager, etc. These features are optional for customers to use. For example, customers may use the online discussion board for group discussions or they may choose in-class group discussions.

From our theoretical perspective, we expect better Information Quality and System Quality of these online services would lead customers to use such functional features more extensively. For example, information that is relevant, easy to understand, and useful could help customers better appreciate the service values offered by IS department through these functional features and they might be induced to try them. To capture the rich use of these functional features for online services that customers experience, we used measures from the deep structure perspective of Burton-Jones and Straub (2006). To measure Intention to Use and to be consistent with our system use measures, we used a four-item scale. A list of System Use and Intention to Use measures is shown in the Table 3-9. With those items we attempt to provide a comprehensive measurement of system usage, which is “a complex activity involving a user, IS, and task over time” (Burton-Jones and Straub 2006, p. 232). Specifically, our measures are related with online system features such as email, discussion board, online calendar, etc., which provide direct support for students to perform various learning tasks, such as learning from instructors about problem solving skills, scheduling appointments, discussing interesting topics, collaborating on team projects, etc. We select those deep structure measures because they represent the majority of users’ uses of system features that “relate to the core aspects” their task (Burton-Jones and Straub 2006).

Table 3-9 Measures of Intention to Use and System Use

Constructs	List of Measures
Intention to Use	1. I would like to use the Web-based learning application to manage my course material
	2. I would like to use the Web-based learning application if I can
	3. I would like to recommend the Web-based learning application functions to others
	4. I would like to recommend others to use the Web-based learning application functions such as email, discussion board, etc. for class learning
System Use	1. When I use the Web-based learning application, I used features that helped me communicate with my instructors regarding class learning issues (e.g., online email, online discussion board, or announcement board, etc.)
	2. When I use the Web-based learning application, I used features that helped me communicate with my classmates regarding class learning issues (e.g., online email, online discussion board, announcement board, chat and whiteboard, etc.)
	3. When I use the Web-based learning application, I used features that helped me plan and schedule class events (e.g., online calendar management, online syllabus)

	4. When I use the Web-based learning application, I used features that helped me manage my learning materials (e.g., file management)
	5. To communicate with my classmates, I used those functional features of Web-based learning application (e.g., email, online discussion board, etc.) most of time
	6. To manage my learning progress, I often used those functional features of Web-based learning application (e.g., online calendar management, online syllabus, online grade listing, etc.)

The measurement of User Satisfaction has been a focus in many studies (e.g., Bailey and Pearson 1983; Ives, Olson et al. 1983; Baroudi and Orlikowski 1988). In fact, in many of those early studies Information Quality and System Quality measures are used as User Satisfaction measures. However, in the later IS Success Models (e.g., DeLone and McLean 1992; Seddon 1997), User Satisfaction is treated as an overall user judgment or evaluation that could be influenced by a number of distinct key factors such as Information Quality, System Quality, Service Quality, and Intention to Use. To capture User Satisfaction at overall level, some studies have used single-item measure (e.g., Baroudi and Orlikowski 1988; Rai, Lang et al. 2002). Others have used multi-item measures (e.g., McKinney, Yoon et al. 2002). Although the single-item measure is easy to use, we follow a multi-item measurement approach to be able to test reliability. In particular, we apply semantic differential scales to measure overall User Satisfaction. With semantic differential scales, the measures of overall User Satisfaction consist of three bipolar adjective pairs such as “Very dissatisfied: and Very satisfied,” “Very displeased: and Very pleased,” and “Terrible: and Delighted.” In this case, each pair represents two extreme ends of an 11 interval scale.

After three pilot tests with a total of 79 users of the Web-based learning application and getting their feedback on wording, content, format, etc. and several rounds of thorough reviews by two expert participants in this study, we finalized our questionnaire with 62 items, which represented all constructs (as shown in Figure 2-7). Appendix C shows the complete questionnaire. Our final questionnaire was administered to 294 users of the same Web-based learning application used in the previous content validation and pilot tests. Exactly 277 (completion rate = 94.2%) completed the questionnaire. All users were students who had applied the Web-based learning application in their courses and used the system for managing learning materials, communicating with classmates or instructors, group discussing, scheduling class events, etc.

The construct validation of Information Quality, System Quality, and Service Quality measures was conducted through a test of their nomological network, as shown in Figure 3-1.

3.4.1 **Analysis**

Data analysis includes an examination of descriptive statistics, the proposed measurement model, and the structural model. This can be conducted through the test of the nomology of the aforesaid constructs. Specifically, we assessed the nomological models involving System Quality, Information Quality (as shown in Figure 3-1), and Service Quality.

3.4.1.1 Reliability

Before we assess construct validity, we need assess the reliability of our instrument for consistent measurement. Various techniques such as inter rater reliability, test-retest reliability, internal consistency, etc. assess reliability (Trochim 1999; Straub, Boudreau et al. 2004). The standard coefficient of internal consistency, i.e. Cronbach's α has been commonly used in many IS studies (Boudreau and Robey 2005). Since Information Quality and System Quality measures are formative, the internal consistency among these measures is not testable (Chin 1998; Chin 1998; Gefen, Straub et al. 2000). Instead, reliability assessment in an approach of test-retest is recommended (Petter, Straub et al. 2007; Diamantopoulos, Riefler et al. 2008).

In this study, using 37 respondents we conducted a test-retest evaluation of the reliability of formative measures at two points in time. Demographics of the respondents are displayed in Table 3-10. Most of them were experienced users of the Web-based online learning application. The time gap between these two points was two weeks based on Nunally's (1978) suggestion that memory would have less influence after two weeks. Respondents were selected from the same pool of users as those selected for the full model test. Respondents had no prior knowledge that the first test would be repeated two weeks later. The respondents' names and unique email addresses of two tests are checked for consistency and to generate matching pairs. Total thirty seven matching responses were found. Only three members of the initial group were not able to attend the second test.

Table 3-10 Demographics of test-retest respondents

Gender	***Number***	***Percentage***
Male	16	43.2%
Female	21	56.7%
Years of using Web-based online learning application		
0~1	10	27%
2~3	22	59.5%
4 or more	5	13.5%
Experience in the system		
Less experience	0	0%
Moderate experience	16	43.2%
Advanced experience	21	56.8%

Table 3-11 provides a summary of test and retest statistics for each Information Quality items. The Cronbach's alphas in Table 3-11 are also calculated based on the test and retest scores (ranging from .598 ~ .815). Applying .70 as a widely accepted cutoff value of Cronbach's alpha, the only measure that has problematic reliability is consistency. Overall, eight out of nine Information Quality measures demonstrate sufficient reliability. Even consistency is close to

Nunnally's 1967 cutoff threshold value of .60 for exploratory work, but we decided to be conservative and not use the item.

Table 3-11 Test-retest statistics for Information Quality Measures

Item	*Test1 (T1)*		*Test2 (T2)*		*Correlation*	*Cronbach's*
	Mean	*SD*	*Mean*	*SD*	*T1 & T2*	*Alpha*
Currency	5.297	1.222	5.135	1.294	.589**	.740
Format	4.622	1.479	5.000	1.453	.685**	.813
Trustful	5.216	1.250	5.297	1.199	.568**	.724
Completeness	5.162	1.214	5.243	1.157	.668**	.799
~~Consistency~~	~~5.351~~	~~1.184~~	~~5.487~~	~~1.193~~	~~.426**~~	~~.598~~
Accuracy	5.432	1.068	5.270	1.146	.673**	.804
Understandability	5.649	1.160	5.405	1.322	.693**	.815
Usefulness	5.243	1.188	5.216	1.336	.718**	.833
Relevancy	5.405	1.189	5.162	1.323	.681**	.807

**. Correlation is significant at the 0.01 level (2-tailed)

Table 3-12 shows the test-retest results of System Quality items. The statistics indicate that most of these items are reliable measures given .70 as a cutoff value for Cronbach's alpha. The only problematic item is "integration." Dropping this item, we keep the rest seven System Quality items as reliable measures of System Quality.

Table 3-12 Test-retest statistics for System Quality Measures

Item	*Test1 (T1)*		*Test2 (T2)*		*Correlation*	*Cronbach's*
	Mean	*SD*	*Mean*	*SD*	*T1 & T2*	*Alpha*
reliability	4.568	1.923	.4838	1.724	.573**	.729
accessibility	5.378	1.187	5.189	1.578	.702**	.806
entertainment	4.000	1.764	4.541	1.742	.714**	.833
sophistication	4.811	1.330	4.784	1.601	.659**	.786
response time	5.000	1.453	4.703	1.730	.608**	.749
~~integration~~	~~5.216~~	~~1.182~~	~~4.811~~	~~1.525~~	~~.455**~~	~~.612~~
ease of use	5.595	1.257	5.297	1.561	.601**	.740
up-to-date facility	4.243	1.422	4.514	1.346	.629**	.772

**. Correlation is significant at the 0.01 level (2-tailed)

Table 3-13 shows the test-retest results of our selected Service Quality measures. The correlations between each pair of the test and the retest items are all significant. The Cronbach's alphas show that both "Perform service right" and "Keep user updated" fail to meet reliability requirement at 0.7 level. Dropping these three items we have total 11 items remained as reliable measures of Service Quality.

Table 3-13 Test-retest statistics for Service Quality Measures

Item	***Test1 (T1)***		***Test2 (T2)***		***Correlation***	***Cronbach's***
	Mean	***SD***	***Mean***	***SD***	***T1 & T2***	***Alpha***
Convenient operation hours	4.568	1.068	4.865	1.084	.596**	.747
~~Perform service right~~	~~4.568~~	~~1.281~~	~~4.595~~	~~1.404~~	~~.487**~~	~~.653~~
Has user interest in heart	4.595	1.117	4.730	1.045	.760**	.863
~~Keep user updated~~	~~5.081~~	~~1.256~~	~~4.919~~	~~1.299~~	~~.396**~~	~~.567~~
Willingness to help	4.838	1.118	4.757	1.065	.666**	.799
Capability to do what is promised	4.784	1.250	4.757	1.256	.602**	.752
Knowledge to do job well	4.865	1.206	4.784	1.272	.632**	.774
Sincere interest toward problem solving	4.703	1.244	4.676	1.156	.704**	.825
Responsiveness to user	4.487	1.044	4.757	1.011	.773**	.872
Capability to keep user information safe	4.946	1.268	4.865	1.159	.543**	.702
Consistent courteousness	4.757	1.091	4.757	1.164	.805**	.891
Capability to give user individual attention	4.568	1.042	4.676	1.107	.718**	.835
Capability to understand user needs	4.730	1.071	4.784	1.294	.638**	.771

**. Correlation is significant at the 0.01 level (2-tailed)

3.4.1.2 Descriptive Statistics

The Table 3-14 provides the demographics of the respondents who participated in the full model test. Most of respondents (98.2%) had at least moderate experience in using the Web-based online learning application.

Table 3-14 Demographics of model test respondents

Gender	***Number***	***Percentage***
Male	137	49.5%
Female	140	50.5%
Years of using Web-based online learning system		

0~1	72	26%
2~3	166	59.9%
4 or more	39	14.1%
Experience in the system		
Less experience	5	1.8%
Moderate experience	122	44%
Advanced experience	147	53.1%
Missing value	3	1.1%

An examination of the data showed that some cases have missing values for different items (as shown in Table 3-15). Since the proportion of our missing data is quite low (e.g., <10%), the application of SEM such as LISREL for model estimate is sensible (Kline 1998). There are several ways to deal with missing values such as "dropping variables," "list-wise deletion / dropping cases," "pair-wise deletion," etc. (Cohen, Cohen et al. 2003, p. 433-434). Among these methods the list-wise deletion is most straightforward and causes fewer problems for SEM-based analysis if the number of cases with missing values is only a small portion of the overall sample (Kline 1998). In our case, we choose to delete those cases since our sample size after deletion is not substantially different from the original sample size.

Table 3-15 Missing Values for IS Quality Measures

	N	***Mean***	***SD***	***Missing***	
				Count	***Percent***
Information Quality Measures					
Relevancy	277	5.16	1.42	0	0
Currency	277	4.9	1.49	0	0
Accuracy	276	5.24	1.31	1	0.4%
Completeness	277	5.12	1.36	0	0
Format	275	4.34	1.62	2	0.7%
Usefulness	277	5.05	1.34	0	0
Trustfulness	276	5.13	1.37	1	0.4%
Understandability	276	5.46	1.18	1	0.4%
Global measure 1	270	5.06	1.35	7	2.5%
Global measure 2	271	5.13	1.33	6	2.2%
Global measure 3	270	5.10	1.31	7	2.5%
System Quality Measures					
Reliability	276	4.52	1.77	1	.4%
Accessibility	275	5.08	1.42	2	.7%

Response time	273	4.59	1.50	4	1.4%
Entertainment	276	3.91	1.69	1	.4%
Ease of use	273	5.22	1.49	4	1.4%
Sophistication	276	4.33	1.48	1	.4%
Up-to-date facilities	274	4.40	1.37	3	1.1%
Global measure 1	271	4.93	1.48	6	2.2%
Global measure 2	270	4.97	1.49	7	2.5%
Global measure 3	270	4.99	1.51	7	2.5%
Service Quality Measures					
Convenient operation hours	275	4.60	1.23	2	0.7%
Has user interest in heart	276	4.53	1.11	1	0.4%
Willingness to help	276	4.61	1.12	1	0.4%
Capability to do what is promised	274	4.55	1.17	3	1.1%
Knowledge to do job well	274	4.75	1.15	3	1.1%
Sincere interest toward problem solving	274	4.53	1.25	3	1.1%
Responsiveness to user	276	4.42	1.10	1	0.4%
Capability to keep user information safe	275	4.80	1.22	2	0.7%
Consistent courteousness	276	4.65	1.13	1	0.4%
Capability to give user individual attention	275	4.46	1.13	2	0.7%
Capability to understand user needs	276	4.61	1.09	1	0.4%

3.4.1.3 Multicollinearity Assessment

For formative measures, “multicollinearity is an undesirable property … as it causes estimation difficulties” (Diamantopoulos, Riefler et al. 2008, p. 1212). High collinearity among formative indicators could lead one to question the distinctiveness of each item in capturing the latent concept. More specifically, indicators that “are almost perfect linear combinations of other likely contain redundant information, which implies the need to consider their exclusion from the index” (Bruhn, Georgi et al. 2008, p. 1298). To determine whether multicollinearity exists among formative measures, VIF (variance inflation factor) statistic is often used (Petter, Straub et al. 2007). In this study, collinearities of Information Quality, System Quality, and Service Quality measures are assessed since all of them are formative measures. The VIFs for our Information Quality measures are in a range of 1.97 ~ 3.57. The VIFs for the System Quality measures are in a range of 1.815 ~ 2.641. The VIFs for Service Quality measures are in a range of 1.86~4.75. All these imply multicollinearity is not an issue as all these VIFs are well below the commonly accepted cutoff threshold of 5~10 (Cohen, Cohen et al. 2003).

3.4.1.4 Validity Assessment of SERVQUAL

Conventionally, the SERVQUAL scale is measured by the difference between customer expectations and their perceptions of actual services performed (Parasuraman, Zeithaml et al. 1988). Other researchers have argued and demonstrated that simple perception-based SERVQUAL measurement such as SERVPERF could be an equivalent or even better alternative compared with the difference-based measurement (e.g., Cronin and Taylor 1992; Cronin and Taylor 1994). In this study, to simplify the instrumentation process, we used only performance-based SERVQUAL measures. Instead of using these measures as reflective measures of SERVQUAL sub dimensions (Kettinger and Lee 1994; Pitt and Watson 1995; Kettinger and Lee 1997; Jiang, Klein et al. 2002), we use them as formative measures of SERVQUAL itself. The original development of SERVQUAL measures was first based on 10 dimensions identified in an exploratory research conducted by Parasuraman et al. (1985) using focus groups from four different services including credit card, security brokerage, retail banking, product repair and maintenance. In their later study (Parasuraman, Zeithaml et al. 1988), their 97 items "representing various facets of these 10 service quality dimensions" (p.17) were developed as an initial pool for SERVQUAL scale. The final SERVQUAL sub-dimensions and their measures were established through a purification process that utilizes iterative computation of Cronbach coefficient alphas, item-to-total correlation, and confirmatory factor analysis. Their use of regression analysis to examine the importance of each SERVQUAL dimensions in determining the overall customer service quality rating suggests that these dimensions are formative dimensions. Their use of factor loadings of SERVQUAL measures on their dimensions to determine which measures should be retained indicates that the final remained measures would be those reflective measures of their corresponding dimentions. However, later studies have found that these measures are not always consistent in representing the dimensions they were measuring (e.g., Kettinger and Lee 1994; Pitt and Watson 1995; Kettinger and Lee 1997; Jiang, Klein et al. 2002).

For formative measures, the traditional validation approach of assessing convergent and discriminant validity does not apply as “there is no restriction on the magnitude of correlations between indicators” (Petter, Straub et al. 2007, p. 641). Some studies using formative measures have examined factor weightings rather than factor loadings for validation purpose (Diamantopoulos, Riefler et al. 2008). Diamantopoulos and Winkhofer (2001) proposed an approach using the multiple indicator multiple causes (MIMIC) model to assess both the weights of formative measures and overall model fit when a measurement model is formatively constructed. In MIMIC models, a formative indictor x_1 is modeled as a direct cause of its latent variable η (Joreskog and Sorbom 1996). Usually, a formative measurement model without any reflective measures can cause identification problems when it is estimated with covariance-based SEM techniques such as LISREL. To solve this problem, reflective indicators are needed in a MIMIC model (Joreskog and Sorbom 1996).

In this study, we developed three global measures for each latent variable of Service Quality, Information Quality, and System Quality. These global measures are used in our MIMIC models as reflective indicators since they each provides a summary of “the essence of the construct” and are good candidates of reflective measures for latent constructs (Diamantopoulos, Riefler et al. 2008, p. 1215). In this study, we first test our 11 item MIMIC model of Service Quality (in Figure 3-2) with LISREL. The Table 3-16 presents the means, standard deviations, and correlations of those items. All correlations are evaluated for statistical significance at 0.01 alpha protection level (Straub, Boudreau et al. 2004).

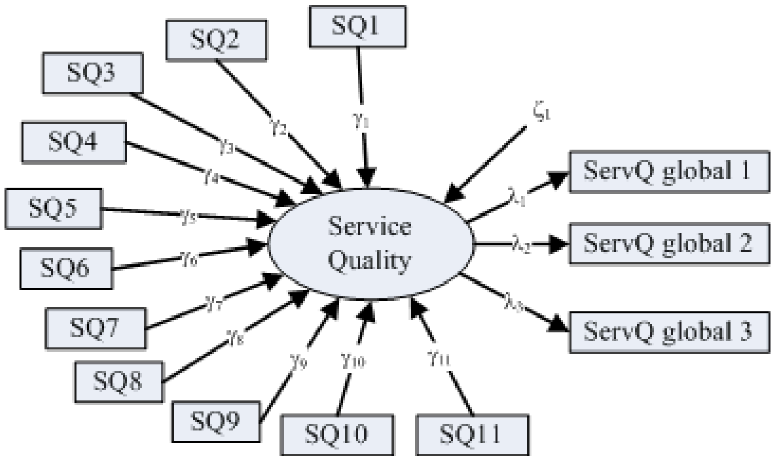

Figure 3-2 MIMIC Model for Service Quality

Table 3-16 Correlations of SERVQUAL Measures

Items	***M***	***SD***	***SQ 1***	***SQ 2***	***SQ 3***	***SQ 4***	***SQ 5***	***SQ 6***	***SQ 7***	***SQ 8***	***SQ 9***	***SQ 10***	***SQ 11***	***Glob 1***	***Glob 2***	***Glob 3***
SQ 1	4.49	1.27	1													
SQ 2	4.53	1.18	0.81	1												
SQ 3	4.59	1.12	0.71	0.71	1											
SQ 4	4.36	1.10	0.79	0.75	0.78	1										
SQ 5	4.84	1.24	0.61	0.55	0.62	0.57	1									
SQ 6	4.65	1.13	0.70	0.69	0.76	0.72	0.69	1								
SQ 7	4.76	1.15	0.67	0.65	0.75	0.71	0.62	0.76	1							
SQ 8	4.61	1.26	0.64	0.60	0.63	0.67	0.58	0.68	0.67	1						
SQ 9	4.42	1.13	0.65	0.59	0.67	0.71	0.54	0.69	0.70	0.74	1					
SQ 10	4.52	1.12	0.71	0.69	0.69	0.77	0.60	0.73	0.70	0.71	0.78	1				
SQ 11	4.61	1.07	0.63	0.60	0.65	0.62	0.60	0.69	0.71	0.64	0.66	0.68	1			
Glob 1	4.98	1.4	0.48	0.44	0.45	0.45	0.43	0.43	0.44	0.45	0.41	0.46	0.56	1		
Glob 2	4.94	1.36	0.43	0.42	0.41	0.40	0.43	0.41	0.41	0.44	0.42	0.39	0.54	0.93	1	
Glob 3	4.92	1.44	0.48	0.46	0.43	0.43	0.42	0.4	0.43	0.47	0.40	0.43	0.56	0.89	0.92	1

(All correlations are significant at 1 percent level)

Since multicollinearity among the formative measures could be a factor that "destabilize[s] the model" (Petter, Straub et al. 2007, p. 641), we also assessed the variance inflation factor (VIF), a key indicator of whether there exists multicollinearity, for all these measures. The results imply multicollinearity is not an issue as all VIFs (in a range of 1.86 ~ 4.75) are well below commonly accepted cutoff threshold of 5 ~ 10 (Cohen, Cohen et al. 2003).

We ran the MIMIC model of Service Quality using LISREL. The resulting list of popular fit indices used in IS literature (e.g., Thompson, Barclay et al. 1995; Hair, Anderson et al. 1998; Gefen, Straub et al. 2000; Jiang, Klein et al. 2002; Straub, Boudreau et al. 2004) is shown in Table 3-17. The ratio of chi-square to degree of freedom has been used by a few researchers to examine the model fit (Gefen, Straub et al. 2000). Chin and Todd (1995) have suggested an upper limit threshold ratio of $\chi 2$ to degree of freedom to be 3:1. So far, the discussions of choosing appropriate cut-offs of fit indices primarily focus on the models with reflective constructs (Hu and Bentler 1999). For models with a lot of formative constructs, these arguments might not apply.

Table 3-17 Key Fit Indices of Service Quality MIMIC Model

Fit Index	Cutoff	Results
$\chi^2(d.f., p)$		45.13 (22, 0.0026)
$\chi^2/ d.f.$	≤ 5.0	2.05
NFI	≥ 0.95	0.99
CFI	≥ 0.95	0.99
GFI **AGFI**	≥ 0.9 >0.8	0.97 0.87
SRMR	≤ 0.05	0.011
RMSEA	≤ 0.05	0.064

Although the RMSEA index is lower than 0.05, it is still in a range (0.05 ~ 0.08) that Browne et al. (1989) say indicates a reasonable fitting. The weights of our selected SERVQUAL items are shown in Figure 3-3.

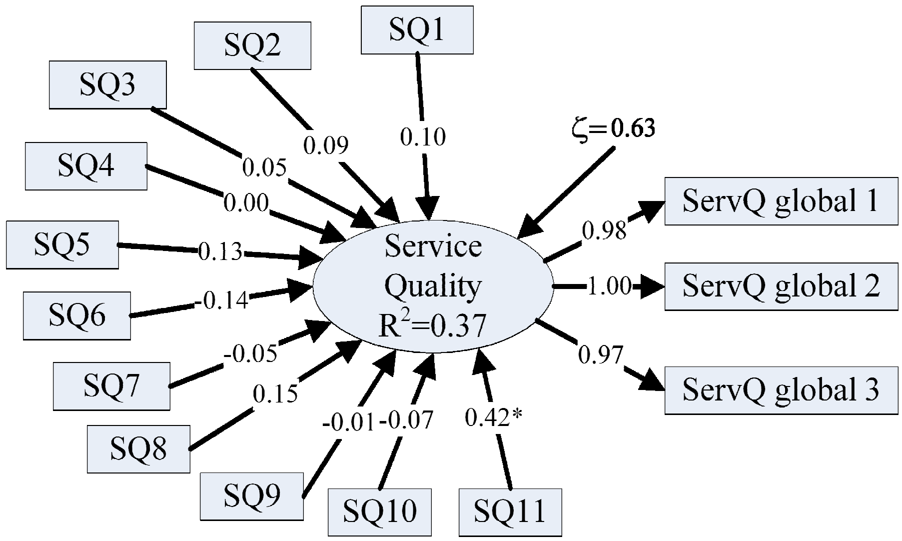

Figure 3-3 LISREL results for service quality MIMIC model

The disturbance term of the Service Quality construct is .63. This term is derived from Square Multiple Correlation (SMC) reported by LISREL. SMC typically represents the a portion of variance of a variable explained by its predictors (e.g., Joreskog and Sorbom 1996). In a reflective measurement model, the disturbance term ζ is related to whether the formative items together explain the variance, and is a surrogate for internal consistency (Diamantopoulos 2006). However, in a formative measurement model, such a term cannot "in any way be interpreted as a measurement error estimate of the indicators … Instead, the variance of ζ represents the residual variance in η after the influence of" measurement items "has been accounted for" (Diamantopoulos 2006, p. 10). In our case, the error term shows approximately 63% variance of our Service Quality construct cannot be explained by our selected SERVQUAL items. This implies that our Service Quality construct has surplus meaning related to "unmeasured causes" (Diamantopoulos 2006, p. 14). In this case, only 37% (R^2 = 0.37) variance of Service Quality can be explained by SERVQUAL items. Following conventional estimation of effect size in multiple regression, a R^2 = 0.37 is still considered to be a large effect size. This result is also consistent with our view that Service Quality in an IT-enabled context is determined not only by

SERVQUAL measures but also by other important quality measures such as Information Quality and Service Quality measures.

Although only one SERVQUAL item has a significant weight (based on 0.05 alpha protection level), weights of formative indicators alone cannot determine whether they are valid measures. Cenfetelli et al. (2009) suggest that bivariate correlation between a indicator and its formatively measured construct should also be evaluated as "a researcher may conclude from a low or nonsignificant indicator weight that the indicator is unimportant despite what may be a significant zero-order correlation, thus supporting that the indicator is, indeed, important" (p. 697). Since Table 3-16 shows that all our selected SERVQUAL measures have significant correlations with the formatively measured Service Quality construct, we decide to retain all these items to ensure content validity (Bollen and Lennox 1991).

3.4.1.5 Validity Assessment of Information Quality

As we have discussed in the previous sections, our selected Information Quality measures should be modeled as formative measures of the Information Quality construct. A MIMIC model (shown in the Figure 3-4) was developed to assess the validity of these Information Quality measures. In this MIMIC model, we have 8 Information Quality measures including accuracy, format, currency, usefulness, understandability, completeness, relevancy, and trustfulness; these were selected during the previous contention validation and modeled as formative measures. There were 3 global Information Quality measures modeled as reflective.

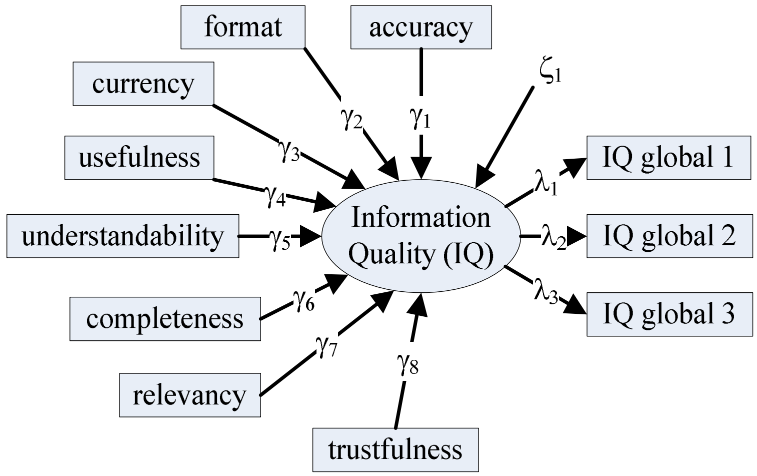

Figure 3-4 MIMIC Model for Information Quality

Table 3-18 presents the means, standard deviations, and correlations of these items. All correlations are evaluated for statistical significance at 0.05 alpha protection level.

Table 3-18 Correlations of Information Quality Measures

Items	***M***	***SD***	***IQ1***	***IQ2***	***IQ3***	***IQ4***	***IQ5***	***IQ6***	***IQ7***	***IQ8***	***Glob 1***	***Glob 2***	***Glob 3***
Relevancy (IQ1)	5.18	1.37	1										
Currency (IQ2)	4.86	1.45	0.72	1									
Accuracy (IQ3)	5.26	1.26	0.49	0.64	1								
Completeness (IQ4)	5.15	1.29	0.47	0.65	0.78	1							
Format (IQ5)	4.38	1.58	0.50	0.58	0.47	0.50	1						
Usefulness (IQ6)	5.13	1.25	0.46	0.59	0.65	0.63	0.6	1					
Trustfulness (IQ7)	5.17	1.32	0.48	0.50	0.61	0.65	0.52	0.67	1				
Understandability (IQ8)	5.50	1.13	0.52	0.53	0.50	0.46	0.36	0.54	0.47	1			
Glob 1	5.07	1.33	0.51	0.55	0.54	0.47	0.53	0.55	0.51	0.50	1		
Glob 2	5.16	1.29	0.61	0.60	0.51	0.49	0.56	0.55	0.52	0.51	0.82	1	
Glob 3	5.15	1.27	0.52	0.53	0.49	0.46	0.55	0.54	0.50	0.42	0.80	0.77	1

(All correlations are significant at 0.05 level)

We ran the MIMIC model of Information Quality using LISREL. The LISREL result is shown in Figure 3-5.

Table 3-19 Key Fit Indices of Information Quality MIMIC Model

Fit Index	**Cutoff**	**Results**
χ^2***(d.f., p)***		22.23 (16, 0.14)
χ^2***/ d.f.***	≤ 5.0	1.39
NFI	≥ 0.95	0.99

CFI	≥ 0.95	1.00
GFI **AGFI**	≥ 0.9 >0.8	0.97 0.92
SRMR	≤ 0.05	0.014
RMSEA	≤ 0.05	0.04

All key fit indices in We ran the MIMIC model of Information Quality using LISREL. The LISREL result is shown in Figure 3-5.

Table 3-19 show a good fit of the MIMIC model with sample size = 219 .The weights and loadings of formative and reflective of Information Quality measures are shown in Figure 3-5. The weights of these Information Quality measures suggest that “format,” “understandability,” “relevancy,” and “trustfulness” have significant relative impact on the Information Quality construct.

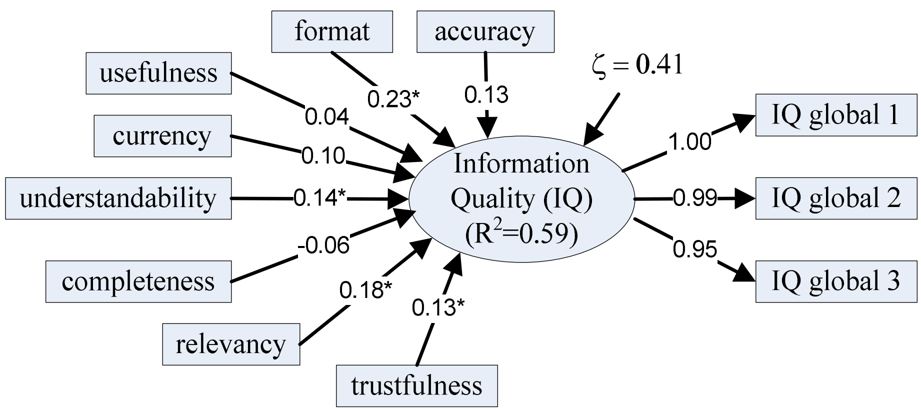

Figure 3-5 LISREL estimates for Information Quality MIMIC Model

Please note that in Table 3-18 presents the means, standard deviations, and correlations of these items. All correlations are evaluated for statistical significance at 0.05 alpha protection level.

Table 3-18 all correlations between Information Quality measures and their formatively measured construct are significant at 0.05 alpha level. This indicates that although “accuracy,” “usefulness,” “currency,” and “completeness” do not have significant weights, they still should be retained since their correlations with Information Quality construct suggest they are important measures in terms of their absolute contribution (Cenfetelli and Bassellier 2009). Therefore, we reatined these eight measures of Information Quality.

The disturbance term in this model (in Figure 3-5) is 0.41. Following Diamantopoulos's suggestion (2006), this disturbance term can be treated as unexplained variance by our MIMIC model. Applying the effect size estimation in multiple regression, we have $R^2 = 0.59$, which is a large effect size (Cohen, Cohen et al. 2003). Overall, these tests using a MIMIC model for the Information Quality construct provide empirical support for construct validity.

3.4.1.6 Validity Assessment of System Quality

For System Quality, there were seven measures selected from previous content validation as formative measures of the System Quality construct. Similar to how we evaluate the validity of Information Quality measures, we developed the MIMIC model shown in Figure 3-6. There are seven formative measures including reliability, accessibility, entertainment, sophistication, response time, and ease of use as well as three global System Quality measures modeled as reflective.

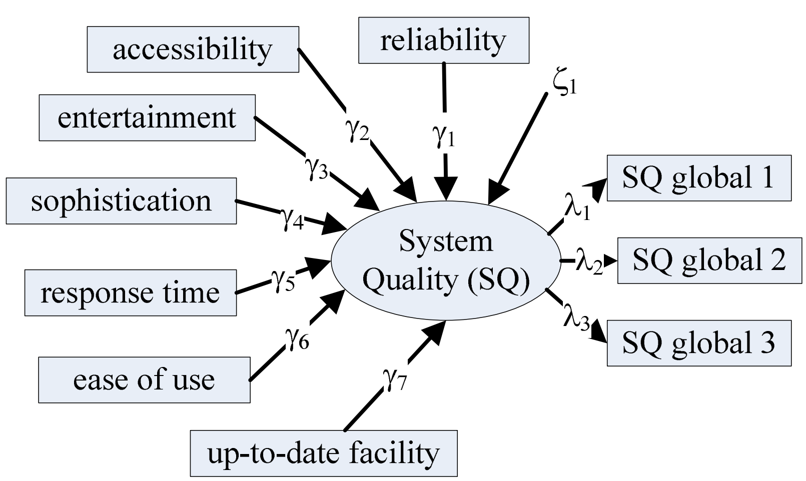

Figure 3-6 MIMIC Model for System Quality

The means, standard deviations, and correlations of these items are shown in the Table 3-20. The statistical significance evaluation at 0.05 alpha protection level show that all correlations among those System Quality measures are significant.

Table 3-20 Correlations of System Quality Measures

Items	*M*	*SD*	*SysQ1*	*SysQ2*	*SysQ3*	*SysQ4*	*SysQ5*	*SysQ6*	*SysQ7*	*Glob 1*	*Glob 2*	*Glob 3*
Reliability (SysQ1)	4.46	1.77	1									
Accessibility (SysQ2)	5.12	1.43	0.54	1								
Responsibility (SysQ3)	4.61	1.51	0.55	0.65	1							
Entertainment (SysQ4)	3.91	1.65	0.47	0.50	0.51	1						
Ease of use (SysQ5)	5.25	1.40	0.41	0.56	0.49	0.57	1					
Sophistication (SysQ6)	4.28	1.47	0.52	0.56	0.54	0.64	0.64	1				
Up to date (SysQ7)	4.38	1.40	0.42	0.43	0.46	0.64	0.53	0.59	1			
Glob 1	4.96	1.41	0.57	0.63	0.63	0.54	0.62	0.65	0.54	1		
Glob 2	5.01	1.44	0.57	0.65	0.59	0.55	0.64	0.64	0.55	0.89	1	
Glob 3	5.04	1.45	0.61	0.70	0.61	0.59	0.62	0.70	0.55	0.87	0.9	1

(All correlations are significant at 0.05 level)

The MIMIC model of System Quality was estimated via LISREL (sample size = 220). The results of fit indices are shown in Table 3-21. Most indices are in a range that indicates an excellent fit of the data to our MIMIC model. Although RMSEA falls a little above the excellent fit range, it is still in the threshold range of (0.05 ~ 0.08) indicating a reasonable fit of the model to the data (Browne and Cudeck 1989).

Table 3-21 Key Fit Indices of System Quality MIMIC Model

Fit Index	Cutoff	Results
χ^2*(d.f., p)*		33.88 (14, 0.002)
χ^2*/ d.f.*	≤ 5.0	2.42
NFI	≥ 0.95	0.99
CFI	≥ 0.95	0.99
GFI **AGFI**	≥ 0.9 >0.8	0.97 0.9
SRMR	≤ 0.05	0.012
RMSEA	≤ 0.05	0.079

The weights and loadings of these System Quality measures are shown in Figure 3-7. The evaluation of statistical significance is at 0.05 alpha level. Except one item “entertainment”, all other System Quality measures have significant weights. Although the weight of the entertainment measure is not significant, its correlations with all other System Quality measures are statistically significant. This indicates that entertainment measure might still be an important formative indicator of System Quality construct (Cenfetelli and Bassellier 2009).

The disturbance term of the System Quality MIMIC model is 0.29. Following our previous discussion of the meaning of disturbance term in a formative construct, the unexplained variance of System Quality construct is 0.29. The R^2 is 0.71, which is quite large effect size according to Cohen and Cohen (2003). Overall, the empirical results out of the System Quality MIMIC model analysis support our use of this formative measurement model.

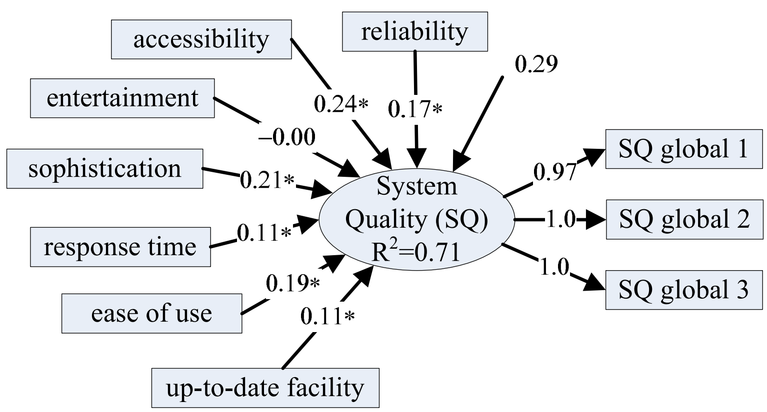

Figure 3-7 LISREL results for System Quality MIMIC Model

So far, our MIMIC model analysis has showed us how well our selected measures support the measurement of their corresponding formative constructs of Information Quality, System Quality, and Service Quality in terms of their individual weights and error terms. According to Petter (2007) the significant weights of formative measures indicate convergent validity. To further confirm the psychometric properties of the instrument, we also assess the discriminant validity of our selected formative measures, we adopt a method developed by Loch and Straub (2003) based on Campbell and Fiske's (1959) multitrait-multimethod (MTMM) analysis. According to this method, the estimated weights of our quality measures from our previous MIMIC model analysis can be treated as influences on their respective formative construct. To create a derived latent variable each for information, system and service quality, all data values of quality were normalized and multiplied by their estimated MIMIC weights. The values of the formatives measures were then summed by construct. In this way these summed values became composite scores for their respective formative construct. Based on these values, we next ran inter-item and item-to-construct correlations and created a matrix of those values.

Following this method, measures thought to demonstrate convergent validity in measuring the same construct should "correlate significantly with their construct value" (Loch, Straub et al. 2003). In Table 8-1(Appendix D), it is clear that all individual Information Quality measures are highly correlated (at 0.01 alpha level) with their composite Information Quality construct value. The individual System Quality measures were also highly correlated (at 0.01 alpha level) with their composite System Quality construct value. The same correlation pattern (at alpha 0.01 level) is observed between individual SERVQUAL measures and their composite Service Quality construct value. According to Loch and Straub (2003), this demonstrates the convergent validity of all our selected measures for Information Quality, System Quality, and Service Quality.

To evaluate the discriminant validity, the inter-item and item-to-construct correlations across constructs were compared. In this case, those items measuring the same formative construct should correlate more highly with each other than those do not (Loch, Straub et al. 2003). An examination of the cross construct correlations in Table 8-1 (Appendix D) shows that all individual measures measuring the same constructs correlate more highly with each other than those measuring different constructs. Therefore, we conclude that the discriminant validity of our selected measures for Information Quality, System Quality, and Service Quality is supported according to this modified MTMM analysis

3.4.1.7 Nomological Validity Assessment of Information Quality and System Quality

Because the extant nomological network of Information Quality and System Quality have typically been developed separately from the nomological network of Service Quality (e.g., Jiang, Klein et al. 2002; Rai, Lang et al. 2002; Nelson, Todd et al. 2005), nomological validity is testedin two separate tests. One part focuses on the nomological test of Information Quality and System Quality as IVs. The second part focuses on a nomological test of Service Quality as an IV. This is Adopted from part of the D&M ISM model tested by Rai et al. in their 2002 article (2002), the nomological network for Information Quality and System Quality is specified in Figure 3-8.

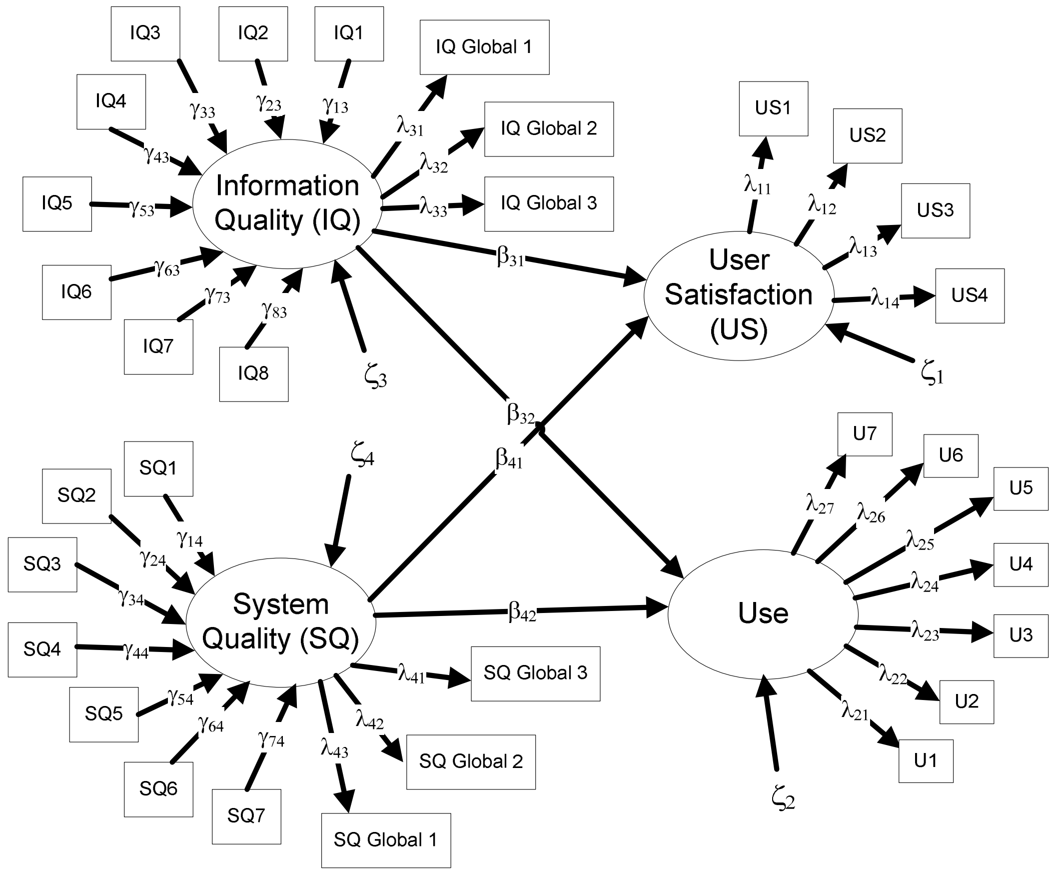

Figure 3-8 Nomological Network of Information Quality and System Quality

With a sample size of 208, this nomological model was estimated with LISREL. All correlations were statistically significant at 0.01 alpha level. The fit indices are shown in Table 3-22. Although some fit indices are below the suggested cut off criteria, they are not too far below. Considering a model with formative constructs a good fit of the model into the data could be difficult and challenging (Wilcox, Howell et al. 2008). In particular, the rules of thumb developed in fit index evaluation literature are mainly based on confirmatory factor analysis, which assumption is dramatically different from a model (like in our case) with a lot of formative constructs.

Table 3-22 Key Fit Indices of Nomological Model for System and Information Quality

Fit Index	Cutoff	Results
$\chi^2(d.f., p)$		727.81 (354, 0.00)
$\chi^2/ d.f.$	≤ 5.0	2.06

NFI	≥ 0.95	0.86
CFI	≥ 0.95	0.92
GFI	≥ 0.9	0.82
AGFI	> 0.8	0.73
SRMR	≤ 0.05	0.084
RMSEA	≤ 0.05	0.071

The estimates of weights, loadings, disturbance terms (derived from SMC), and paths of the nomological model are shown in Figure 3-9. Both Information Quality and System Quality have significant impacts on their nomological outcome variables such as User Satisfaction and system use. This confirms Rai et al's 2002 assessment of the IS Success Model (shown in Figure 3-10) as well as similar findings in other studies (e.g., McKinney, Yoon et al. 2002; Nelson, Todd et al. 2005).

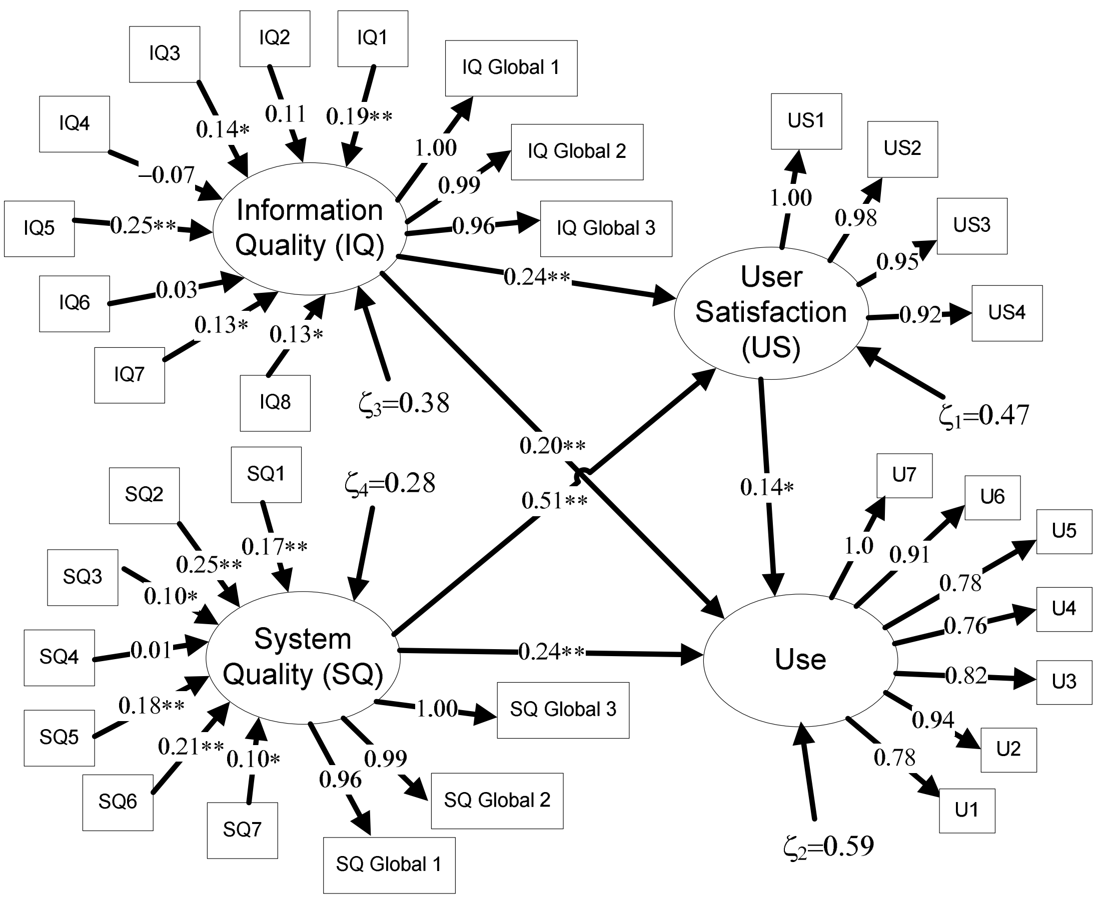

Figure 3-9 LISREL results for nomological network of IQ and SQ

*Note: * represents significance at 0.05 level and ** represents significance at 0.01 level*

Overall, the empirical results show that our selected measures of System Quality and Information Quality satisfy the nomological validity requirement.

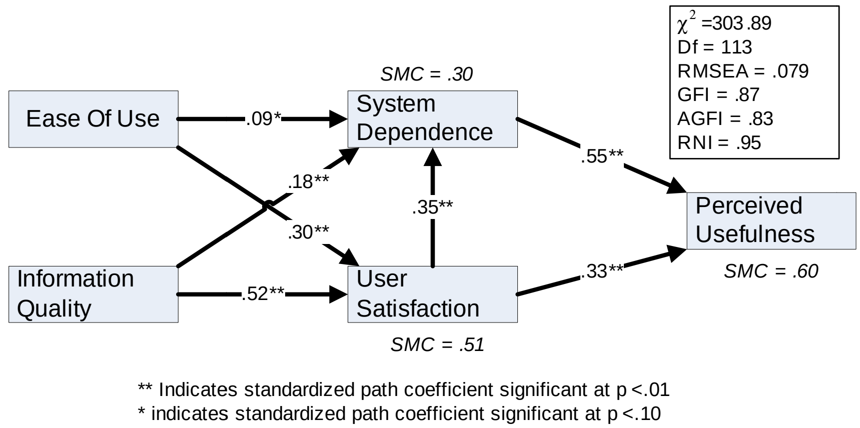

Figure 3-10 A Recap of DeLone and McLean Model Tested By Rai et al. (2002)

In the IS literature the Service Quality was typically studied by itself as it has a complicated dimensional structure (e.g., Kettinger, Lee et al. 1995; Pitt and Watson 1995; Kettinger and Lee 2005). A few studies have examined the relationship between Service Quality and User Satisfaction (e.g., Kettinger and Lee 1994; Jiang, Klein et al. 2002). Based on these studies we tested our own nomological validity (Figure 3-11) for Service Quality.

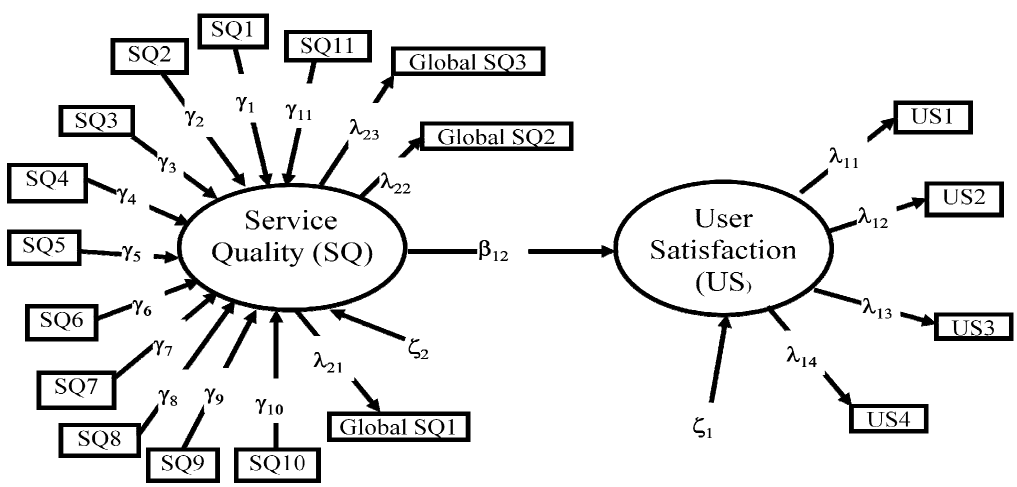

Figure 3-11 Nomological Network of Service Quality

Next we tested the nomological vality of Service Quality using LISREL. The fit indices are displayed in Table 3-23. Since all these indices are above typical cut off values, our Service Quality nomological model can be interpreted as being well supported.

Table 3-23 Key Fit Indices of Nomological Model for Service Quality

Fit Index	Cutoff	Results
$\chi^2(d.f., p)$		120.12 (79, 0.00)
$\chi^2/ d.f.$	≤ 5.0	1.52
NFI	≥ 0.95	0.97
CFI	≥ 0.95	0.99
GFI **AGFI**	≥ 0.9 >0.8	0.95 0.94
SRMR	≤ 0.05	0.029
RMSEA	≤ 0.05	0.043

The weights and loadings of the main constructs in this model are show in Figure 3-12. The path between Service Quality and User Satisfaction shows a strong relationship between Service Quality and User Satisfaction. This confirms the findings in the literature (e.g., Kettinger and Lee 1994; Jiang, Klein et al. 2002).

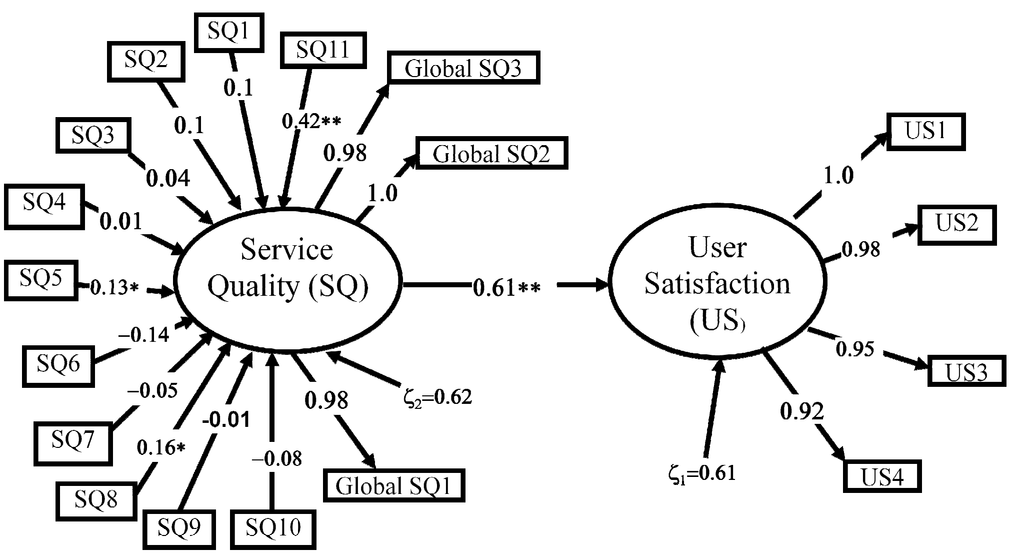

Figure 3-12 LISREL estimates for nomological network of Service Quality
*Note: * represents significance at 0.05 level and ** represents significance at 0.01 level*

Overall, these nomological tests confirm significant relationships between IS quality constructs and their downstream variables such as User Satisfaction just as has been found in past IS studies (e.g., Ives, Olson et al. 1983; Kettinger and Lee 1994; McKinney, Yoon et al. 2002; Rai, Lang et al. 2002). Therefore, we can conclude that our IS quality instrument meets the nomological validity requirement.

3.5 Summary

Through our instrument development process, we have developed a set of appropriately validated IS quality measures. Our next step is then to use those measures to test both a larger part of the 2003 DeLone and McLean ISM and the proposed alternative model that involve IS quality constructs and the constructs of Intention to Use/Use and User Satisfaction.

4. MODELS TESTS

Once we created a complete set of validated measures of Information Quality, System Quality, and Service Quality, the next step was to test proposed theoretical hypotheses with respect to the theoretical model shown in Figure 2-7. For convenience we also report our previous theoretical hypotheses in Table 4-1.

Table 4-1 Hypotheses under Test

Hypothesis #	Hypothesis
H1	Service Quality mediates both the relationship between System Quality and Intention to Use/Use and the relationship between System Quality and User Satisfaction.
H2	Service Quality mediates both the relationship between Information Quality and Intention to Use /use and the relationship between Information Quality and User Satisfaction.
H3	Service Quality has a positive impact on Intention to Use /Use.
H4	Service Quality has a positive impact on User Satisfaction.
H5	Use has a positive impact on User Satisfaction.

H6	User Satisfaction has a positive impact on Intention to Use
H7	Information Quality has a positive impact on User Satisfaction
H8	Information Quality has a positive impact on Intention to Use / Use
H9	System Quality has a positive impact on User Satisfaction
H10	System Quality has a positive impact on Intention to Use / Use

Since Service Quality is the only hypothesized mediator, we can test Service Quality as a mediator between independent variables such as Information Quality and System Quality and dependent variables such as Intention to Use, Use, and User Satisfaction using various single-mediator models (MacKinnon, Fairchild et al. 2007). Our first single-mediator model includes Service Quality as a mediator between Information Quality and Intention to Use (as shown in Figure 4-1). Measures of Service Quality and Information Quality are those validated in the previous instrument development process. Measures of Intention to Use are listed in Table 3-9. To test mediation effects within single-mediator models, Baron and Kenny (1986) developed a third steps approach: first is the test of the relationship from the independent variable to the mediator; second is the test of the relationship from the independent variable to the dependent variable; and third is the test of the relationships from the independent variables and the mediator to the dependent variable. The mediation effect can be established when the following conditions hold: “First, the independent variable must affect the mediator” in the first step; “second, the independent variable must affect the dependent variable” in the second step; “third, the mediator must affect the dependent variable in the third step;” and last when “these conditions hold in the predicted direction, then the effect of independent variable on the dependent variable must be less” in the third step (e.g., path c' in Figure 4-1) than in the second step (Barron and Kenny 1986). MacKinnon et al. (2007) has proposed an improved approach to assess mediation by estimating the significance of indirect effect between independen variable and dependent variable to assess mediation. In this case, the indirect effect is formed by the product of coefficient relating mediator to dependent variable and coefficient relating independent variable to mediator. Here, we follow MacKinnon et al.'s approach to test the mediator role of Service Quality.

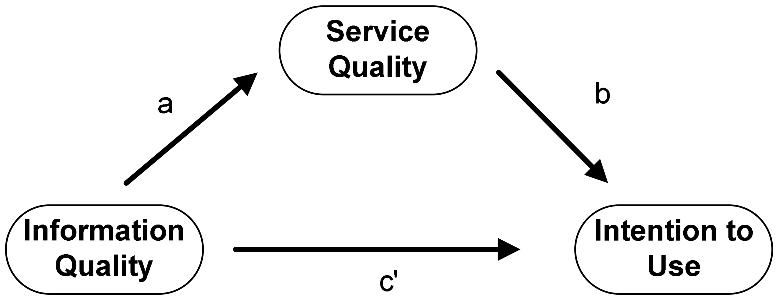

Figure 4-1 Single-Mediator Model 1

In the LISREL analysis, we get estimates of all path coefficients, disturbance terms (derived from SMC) in our first single-mediator model (shown in Figure 4-2), fit indices (shown in Table 4-2), estimates of total effects of Information Quality on Intention to Use, estimates of indirect effects of Information Quality on Intention to Use through Service Quality.

Table 4-2 Fit Indices of Single-Mediator Model 1

Fit Index	Cutoff	Results
χ^2(*d.f., p*)		480 (203, 0.00)
χ^2/ *d.f.*	$\leq$ 5.0	2.36
NFI	$\geq$ 0.95	0.92
CFI	$\geq$ 0.95	0.94
GFI	$\geq$ 0.9	0.86
AGFI	>0.8	0.7
SRMR	$\leq$ 0.05	0.083
RMSEA	$\leq$ 0.05	0.082

Although some of fit indices are below cutoff values, this is not unexpected as the difficulty in fitting a model containing formative indicators is often "apparent in the magnitude of lack of fit" (Howell, Breivek et al. 2007; Wilcox, Howell et al. 2008, p. 1226). Overall, these indices are not too far from good fit thresholds and therefore considered to be acceptable.

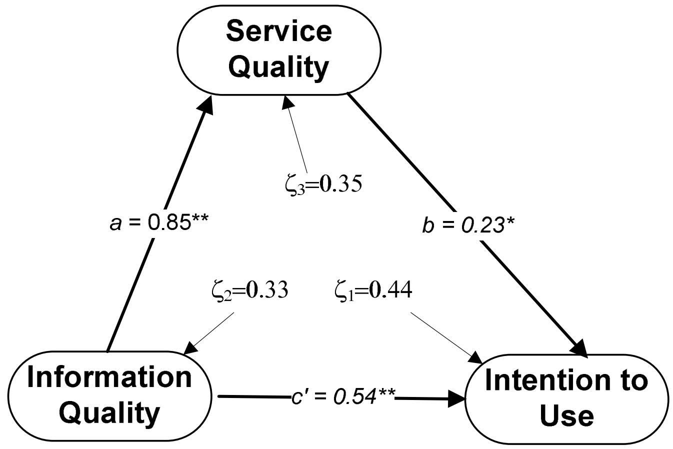

Figure 4-2 Estimates of Single-Mediator Model 1

The estimate of the indirect effect of Information Quality on Intention to Use is 0.19, which is also statistically significant. All these findings clearly indicate a significant mediation effect of Service Quality (e.g., MacKinnon, Lockwood et al. 2002; MacKinnon, Fairchild et al. 2007; Iacobucci 2008). Since the direct path from Information Quality to Intention to Use is also significant, this is a partial mediation (Baron and Kenny 1986). While this is not unexpected as outcome variables such as Intention to Use, Use, and User Satisfaction could have various causes, "it is often unrealistic to expect that a single mediator would be explained completely by an independent variable to dependent variable relation" (MacKinnon, Fairchild et al. 2007, p. 602).

Our next single-mediator model (as shown in Figure 4-3) is developed to assess the mediation effect of Service Quality between System Quality and Intention to Use. The measures of System Quality are those validated in the previous instrument development stage.

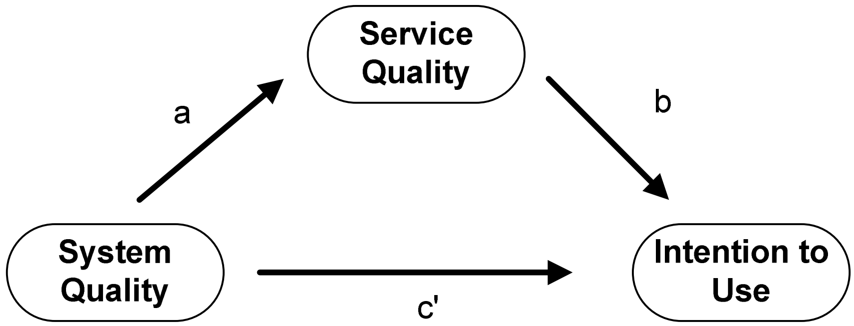

Figure 4-3 Single-Mediator Model 2

The fit indices from the LISREL estimates of this model are shown in Table 4-3. Although some indices are slightly below cutoff thresholds, they can be considered acceptable in that multiple formative constructs are included in this model.

Table 4-3 Fit Indices of Single-Mediator Model 2

Fit Index	Cutoff	Results
χ^2*(d.f., p)*		352.92 (194, 0.00)
χ^2/ *d.f.*	≤ 5.0	1.81
NFI	≥ 0.95	0.94
CFI	≥ 0.95	0.97
GFI	≥ 0.9	0.89
AGFI	>0.8	0.77
SRMR	≤ 0.05	0.047
RMSEA	≤ 0.05	0.063

The LISRE estimates of path coefficients and disturbance terms are shown in Figure 4-4. Results show that the path from Service Quality to Intention to Use has a different sign from the other two paths in the model. The indirect effect from System Quality to Intention to Use through Service Quality is -.21, which is statistically significant. This model is considered to be an inconsistent mediation model as one of mediated effects has a different sign from others (Blaylock and Rees 1984; Davis 1985; MacKinnon, Krull et al. 2000; MacKinnon, Lockwood et al. 2002). In this case, Service Quality is a "suppressing mediator," one suppresses the relationship between System Quality and Intention to Use. "[In] general their omission will lead to an underestimate of the effect of X on Y" (Cohen, Cohen et al. 2003, p. 458).

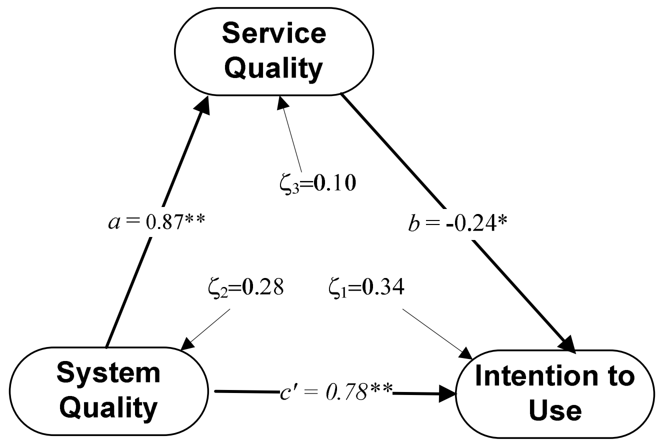

Figure 4-4 Estimates of Single-Mediator Model 2

According to MacKinnon et al. (2007), there could be two opposing mediation processes involved. For example, in an online service environment a lot of service functions are automated or embeded within the information system. Then, the higher user perceived System Quality would certainly lead to higher user perceived Service Quality when the Service Quality is measured with those global level reflective measures. However, in this study, the Service Quality construct also have formative measures, which are selected from SERVQUAL. We know SERVQUAL measures primarily ask user's perception of human support service quality. In an online environment, human support service is only needed when a user has troubles of using the system. In this case, when users are asked about their impression of human support service quality (primarily measured with SERVQUAL items) the higher user perceived human support service quality might signal more troubles that a user has experienced in using a system by him/herself alone. That's why they have to seek support from human provided service. Those who know how to use the system or use the system well might not seek human support service at all. Therefore, they probably don't have much impression of human support service quality. Those who have more troubles of using the system might have less intention to use it even though they received excellent human support service. In an online service environment when the presence of human support service group is minimized and virtualized a user might feel alienated from human service agents and need spend more time and efforts to reach them. If possible, a user certainly wants to avoid using a system at all so that s/he won't even bother seeking out the human support service if there are troubles of using it. Therefore, the higher human support service quality a user perceives could lead to his/her lower intention to use a system. In this case, the Service Quality measured with formative SERVQUAL measures becomes a supressor between System Quality and Intention to Use.

Next, we test the mediation effect of Service Quality between Information Quality and User Satisfaction. The single-mediator model is shown in Figure 4-5. Our measures of User Satisfaction are discussed in 3.4.

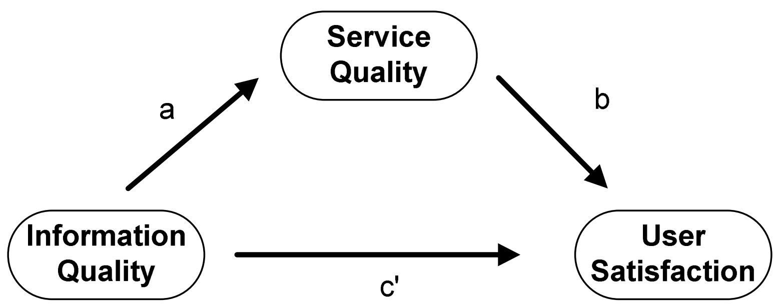

Figure 4-5 Single-Mediator Model 3

The LISREL analysis generates the fit indices shown in Table 4-4. Although some indices do not meet the cutoff threshold, we consider them to be acceptable as it is difficult to achieve a good fit when the formative constructs are involved in the model estimation (Howell, Breivek et al. 2007).

Table 4-4 Fit Indices of Single-Mediator Model 3

Fit Index	Cutoff	Results
χ^2(*d.f., p*)		398.70 (203, 0.00)
χ^2/ *d.f.*	$\leq$ 5.0	1.96
NFI	$\geq$ 0.95	0.93
CFI	$\geq$ 0.95	0.96
GFI	$\geq$ 0.9	0.88
AGFI	>0.8	0.75
SRMR	$\leq$ 0.05	0.079
RMSEA	$\leq$ 0.05	0.069

The estimates of the path coefficients and disturbance terms are shown in Figure 4-6. The indirect effect of Information Quality on User Satisfaction through Service Quality is 0.13, which is insignificant. The path from Service Quality to User Satisfaction is also insignificant. Overall, the mediator role of Service Quality between Information Quality and User Satisfaction is not supported by the result from the single-mediator model 3 estimation procedure. However, such a result shouldn't rule out the mediation effect of Service Quality between Information Quality and User Satisfaction. There could be multiple causes for why such an effect is not presented here. One possible cause could be that many subjects might have little experience of human support service and cannot rate its quality in an appropriate way. These inappropriate quality ratings might have unexpected influences that make it difficult to detect the mediation effect of overall Service Quality on the relation between Information Quality and User Satisfaction.

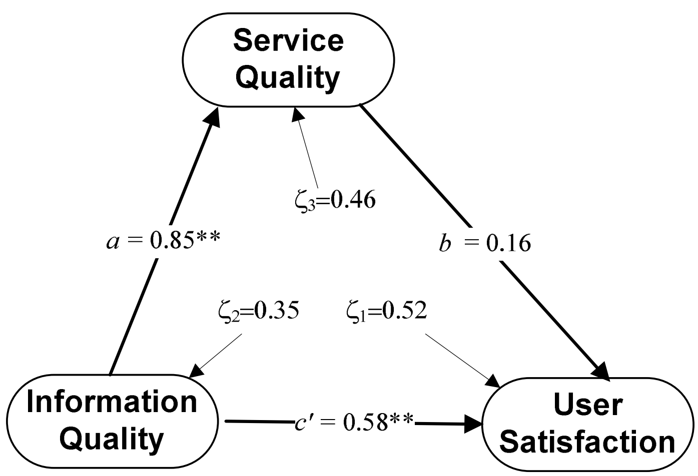

Figure 4-6 Estimates of Single-Mediator Model 3

Next, we assess the mediator role of Service Quality between System Quality and User Satisfaction. This is assessed through the LISREL estimates of the single-mediator model as shown in Figure 4-7.

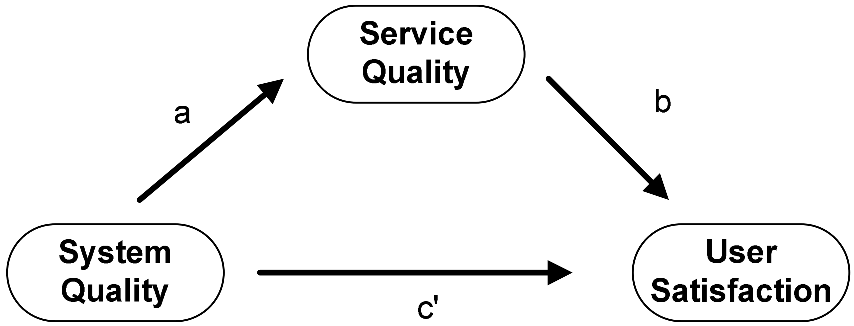

Figure 4-7 - Single-Mediator Model 4

The fit indices appear in Table 4-5. Most of those indices meet the cutoff thresholds. The overall fit of this model is also considered to be quite good.

Table 4-5 - Fit Indices of Single-Mediator Model 4

Fit Index	Cutoff	Results
χ^2*(d.f., p)*		303.36 (194, 0.00)
χ^2/ *d.f.*	≤ 5.0	1.56
NFI	≥ 0.95	0.95
CFI	≥ 0.95	0.98
GFI	≥ 0.9	0.9
AGFI	>0.8	0.79
SRMR	≤ 0.05	0.043
RMSEA	≤ 0.05	0.052

The estimates of the path coefficients and disturbance terms in this model are shown in Figure 4-8. Although the coefficient of the path from System Quality to Service Quality is statistically significant, the path from Service Quality to User Satisfaction is not. LISREL also reports that the indirect effect of System Quality on User Satisfaction through Service Quality is insignificant (-0.16). Overall, the findings from the single-mediator model 4 do not support the mediator role of Service Quality between System Quality and User Satisfaction. Again, lack of support in this study doesn't mean that such a mediation effect doesn't exist. There could be causes like the ones that we discussed above that make this effect hard to detect.

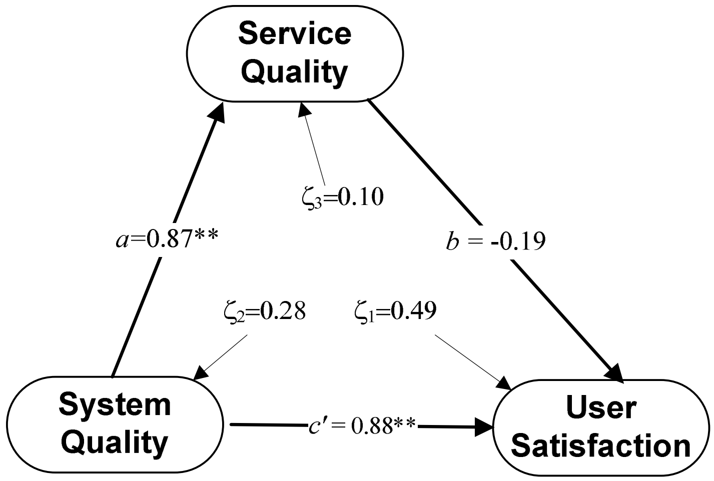

Figure 4-8 Estimates of Single-Mediator Model 4

Last, we assess the mediation effect of Service Quality on the relationship between Information Quality and Use as well as the relationship between System Quality and Use. The single-mediator model consists of the mediated path from Information Quality to Use through Service Quality and is shown in Figure 4-9.

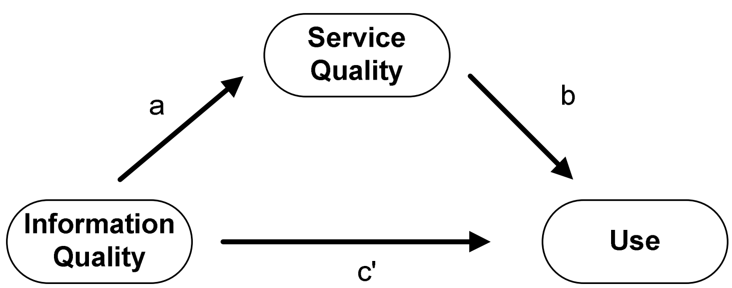

Figure 4-9 - Single-Mediator Model 5

The fit indices from LISREL are listed in Table 4-6. Again, most fit indices are just slightly below cutoff thresholds. Given the fact that most constructs in the model are formative, these results may be considered to be acceptable.

Table 4-6 Fit Indices of Single-Mediator Model 5

Fit Index	Cutoff	Results
$\chi^2(d.f., p)$		590.57 (290, 0.00)
$\chi^2/d.f.$	≤ 5.0	2.04
NFI	≥ 0.95	0.90

CFI	≥ 0.95	0.94
GFI **AGFI**	≥ 0.9 >0.8	0.85 0.73
SRMR	≤ 0.05	0.082
RMSEA	≤ 0.05	0.071

The estimates of the path coefficients and disturbance terms (derived from SMC) are shown in Figure 4-10. All paths are statistically significant. The indirect effect of Information Quality on Use through Service Quality generated by LISREL is significant (0.18) at the 0.05 level. All these findings support the hypothesis that Service Quality mediates the relationship between Information Quality and Use. In particular, since the coefficient of the direct path between Information Quality and Use is significant, this mediation is considered to be a partial mediation (MacKinnon, Fairchild et al. 2007).

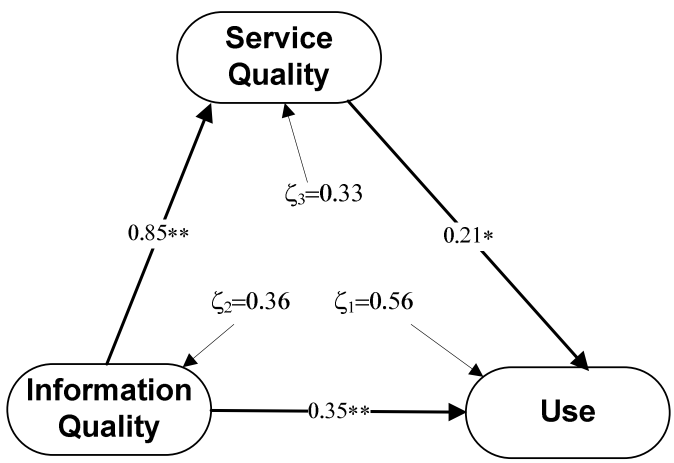

Figure 4-10 Estimates of Single Mediator Model 5

Our last single-mediator model assesses the mediation effect of Service Quality on the relationship between System Quality and Use. The model is shown in Figure 4-11.

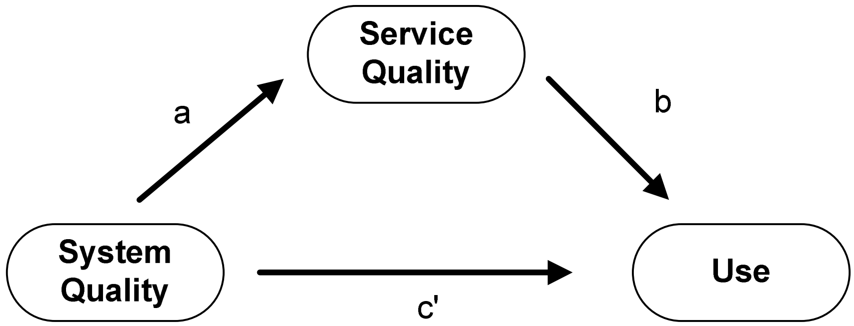

Figure 4-11 Single-Mediator Model 6

The fit indices are listed in Table 4-7 below.

Table 4-7 Fit Indices of Single-Mediator 6

Fit Index	Cutoff	Results
χ^2(*d.f., p*)		434.45 (278, 0.00)
χ^2/ *d.f.*	≤ 5.0	1.56
NFI	≥ 0.95	0.93
CFI	≥ 0.95	0.97
GFI **AGFI**	≥ 0.9 >0.8	0.88 0.79
SRMR	≤ 0.05	0.051
RMSEA	≤ 0.05	0.052

The estimates of the path coefficients and disturbance terms for this model are shown in Figure 4-12. The indirect effect of System Quality on Use is insignificant (0.14). Since the coefficient of the path from the hypothesized mediator Service Quality to the dependent variable Use is insignificant, the mediator role of Service Quality between System Quality and Use is not supported.

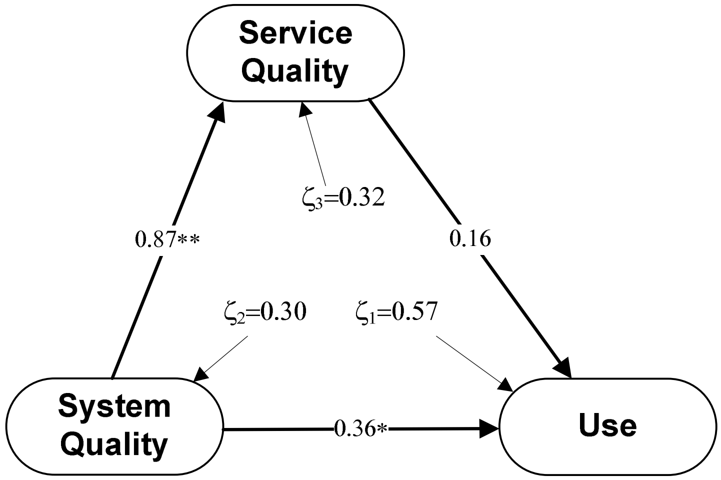

Figure 4-12 Estimates of Single-Mediator 6

Finally, we summarize the findings of all single-mediator model tests in Table 4-8. Among 6 single-mediator tests, two are supported. In particular, the mediation effect of Service quality on the relationship between Information Quality and Intention to Use/Use is supported. Overall, these findings do not support the hypotheses of Service Quality as a mediator between System Quality and IS Success outcome variables such as Intention to Use, Use, and Satisfaction. However, lack of support of those mediation effects in our results doesn't mean they don't exist. Causes such as subjects' biased Service Quality ratings as we have discussed above might make it difficult to detect those mediation effects.

Table 4-8 Testing Results of Service Quality Mediation Effects

Hypothesis #	Hypothesis	Result
H1-a (Figure 4-3)	Service Quality mediates the relationship between System Quality and Intention to Use.	Supported
H1-b (Figure 4-11)	Service Quality mediates the relationship between System Quality and Use.	Not Supported
H1-c (Figure 4-7)	Service Quality mediates the relationship between System Quality and Satisfaction	Supported
H2-a (Figure 4-1)	Service Quality mediates the relationship between Information Quality and Use	Not Supported
H2-a (Figure 4-9)	Service Quality mediates the relationship between Information Quality and Intention to Use.	Not Supported
H2-b (Figure 4-6)	Service Quality mediates the relationship between Information Quality and Satisfaction	Not Supported

To test the rest of the hypotheses in Table 4-1, we need assess two full theoretical models (as shown in Figure 4-13 and Figure 4-15) that include two IS Success variables including User Satisfaction and Intention to Use. There are 7 formative system quality measures and 3 reflective system quality measures. For the Service Quality construct there are 11 SERVQUAL measures that qualify as formative measures and 3 as reflective measures. For the theoretical model 1 (shown in Figure 4-13), it has two IS Success outcome variables including Intention to Use and User Satisfaction. Each of these variables has four reflective measures. The causal path is from Intention to Use to User Satisfaction since "increased 'user satisfaction' will lead to increased 'intention to use'" (DeLone and McLean 2003, p. 23). Here, we run LISREL to estimate the model. The LISREL fitness indices are listed in Table 4-9.

Table 4-9 Key Identification Fit Indices of Full Model 1

Fit Index	Cutoff	Results
χ^2(*d.f., p*)		992.64 (526, 0.00)
χ^2/ *d.f.*	$\leq$ 5.0	1.89
NFI	$\geq$ 0.95	0.88
CFI	$\geq$ 0.95	0.93
GFI **AGFI**	$\geq$ 0.9 >0.8	0.82 0.67
SRMR	$\leq$ 0.05	0.088
RMSEA	$\leq$ 0.05	0.066

Although most indices are below the thresholds of good fit, it is not unexpected as models involving formative constructs are often poorly fitted (Howell, Breivek et al. 2007; Wilcox, Howell et al. 2008).

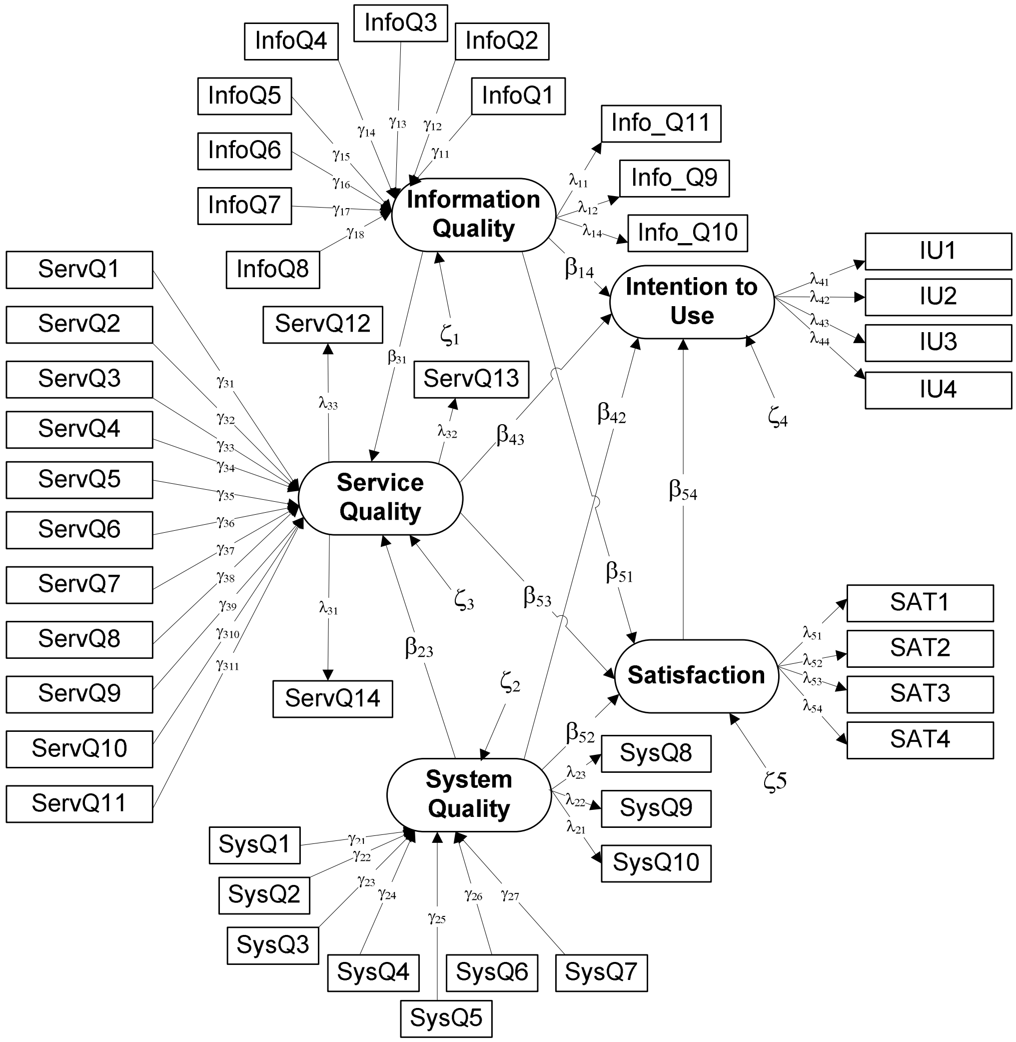

Figure 4-13 Full Model 1

The LISREL estimates of weights, loadings, disturbance terms, and path coefficients of this model are shown in Figure 4-14. The weight estimates of those quality measures in measuring their formative latent variables are consistent with those estimates in the construct validation process we discussed previously. For Service Quality measures, only two SERVQUAL measures have significant weights. This is probably because the SERVQUAL measures traditionally used to measure the quality of labor intensive services do not apply well in measuring Service Quality in an online service environment. In such an environment many traditional human delivered services such as trouble shooting, problem solving, maintenance, etc.

might be fully automated or at least largely enabled with IT components such as online FAQs, knowledge base functions, search engines powered by advanced machine learning algorithms, live chat, emails, etc. The quality of those IT components as well as the information they provide would directly affect a customer's experience of those services. These IT related quality effects seem particularly obvious in our findings. The coefficients of the paths from both Information Quality and System Quality to Service Quality (in Figure 4-14) are statistically significant. When SERVQUAL measures are used to predict the variance of overall Service Quality (in Figure 3-3) there is a 63% unexplained portion. When the Information Quality and System Quality factors are introduced as additional variables to predict the variance of overall Service Quality as shwon in Figure 4-14, the unexplained portion of Service Quality drops to 10%, which is dramatic. Overall, this result implies that in online service environments the quality of technology components and quality of information provided through those components are important determinants of overall Service Quality.

Although we have hypothesized that Service Quality would be an important positive determinant of Intention to Use and User Satisfaction in our previous theoretical discussions, the path coefficients estimated here by LISREL provide no support. The path coefficient between Service Quality and Intention to Use is negative (-0.21) and significant. The path coefficient between Service Quality and Intention to Use is negative but insignificant. Because of the complexity of full model 1 (shown in Figure 4-13), there could be multiple causes for why our original hypotheses on these parts are not supported. One possible cause that we have discussed before in the previous sections is that in an online environment many subjects are lack of experiences dealing with human support services because of the minimized or virtualized presence of those services. Their lack of human support service experiences might make their answers to

SERVQUAL related questions heavily biased, which might have unexpected impact on the analysis of path coefficients between Service Quality and Intention to Use as well as Satisfaction.

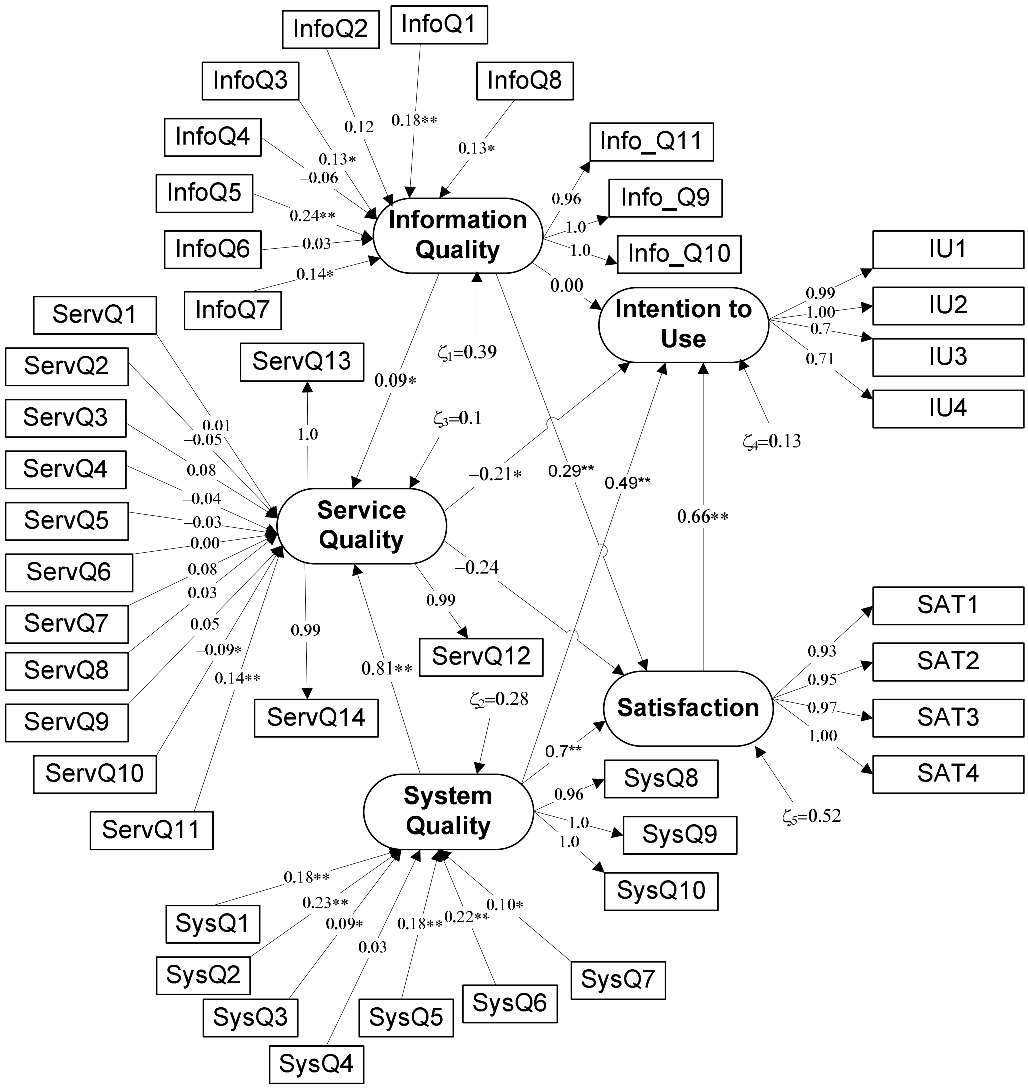

Figure 4-14 Assessment of Full Model 1

Another possible cause would be the complexity of the model itself. The correlation table shows correlations among measures of Service Quality, Intention to Use, and User Satisfaction are all positive. We also ran a separate test involving only Service Quality and Intention to Use and Satisfaction. The result shows that Service Quality is a significant and positive determinant of both IS Success outcome variables. We suspect that the maxmum likelihood algorithm used in

LISREL might not be able to deal with the complexity of the model (as it contains so many formative constructs) well. This might also be the reason to explain why Information Quality lost its role as a significant and postive determinant of Intention to Use while it maintained such a role when it was assessed in a separate and much less complicated model. The hypothesis test results are listed in Table 4-10.

Table 4-10 Hypothesis Test of Full Model 1

Hypothesis #	Hypothesis	Result
H3a	Service quality has a positive impact on Intention to Use.	Not supported
H4	Service quality has a positive impact on User Satisfaction.	Not supported
H6	User Satisfaction has a positive impact on Intention to Use	Supported
H7	Information Quality has a positive impact on User Satisfaction	Supported
H8a	Information Quality has a positive impact on Intention to Use	Not supported
H9	System Quality has a positive impact on User Satisfaction	Supported
H10a	System Quality has a positive impact on Intention to Use	Supported

Next, we test the model (as shown in Figure 4-15) involving the same set of IS quality constructs but a slightly different set of outcome variables. In this case we include Use instead of Intention to Use as shown in Figure 4-13. According to DeLone and McLean (2003, p.23), “positive experience with ‘use’ will lead to greater ‘user satisfaction’ in a causal sense”. Therefore, the path direction between Use and User Satisfaction is from Use to User Satisfaction. The construct Use has 7 reflective measures (listed in Table 3-9). Again, to assess this model we run the LISREL analysis. The fit indices are shown in Table 4-11.

Table 4-11 Key Identification Fit Indices of Model 1

Fit Index	Cutoff	Results
χ^2***(d.f., p)***		1153.60 (655, 0.00)
χ^2***/ d.f.***	≤ 5.0	1.76
NFI	≥ 0.95	0.87
CFI	≥ 0.95	0.93
GFI **AGFI**	≥ 0.9 >0.8	0.81 0.68
SRMR	≤ 0.05	0.08
RMSEA	≤ 0.05	0.06

Compared with the typical cutoff critieria of fit indices (Hu and Bentler 1999), the fit indicies in Table 4-11 look poor. However, those standards are often developed for fitting the models based on reflective measurement (Diamantopoulos, Riefler et al. 2008).

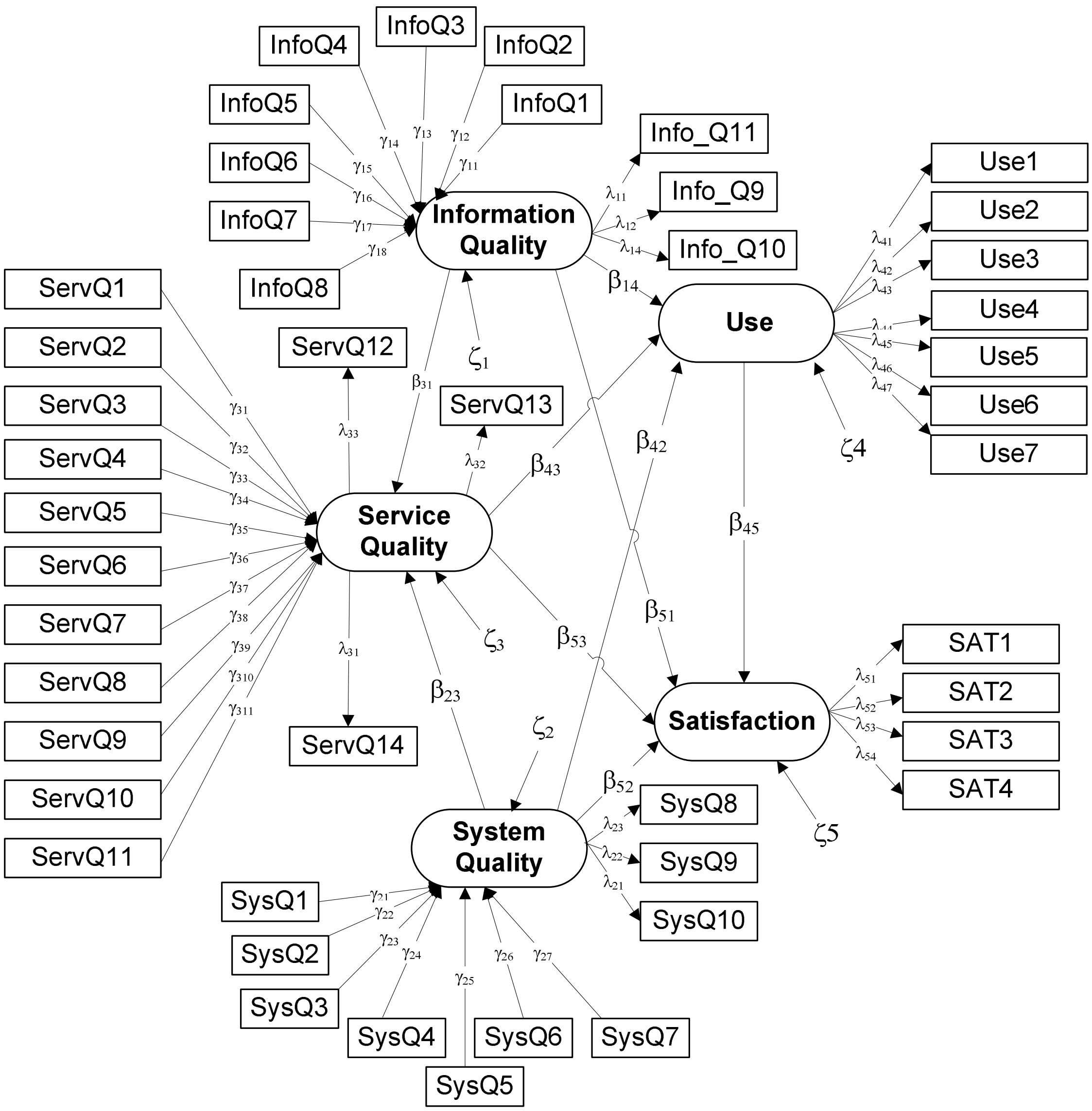

Figure 4-15 Full Model 2

To our knowledge, the cutoff criteria for fitting models with formative measures have not been well studied. To what degree those cutoff criteria used for fitting models with reflective measurement applies to fitting the models with formative measures remain unknown although we know those models typically experienced poor fit (Howell, Breivek et al. 2007).

The LISREL estimates of weights, loadings, path coefficients, and disturbance terms of the model are shown in the Figure 4-16. The results are similar to the model shown in Figure 4-14.

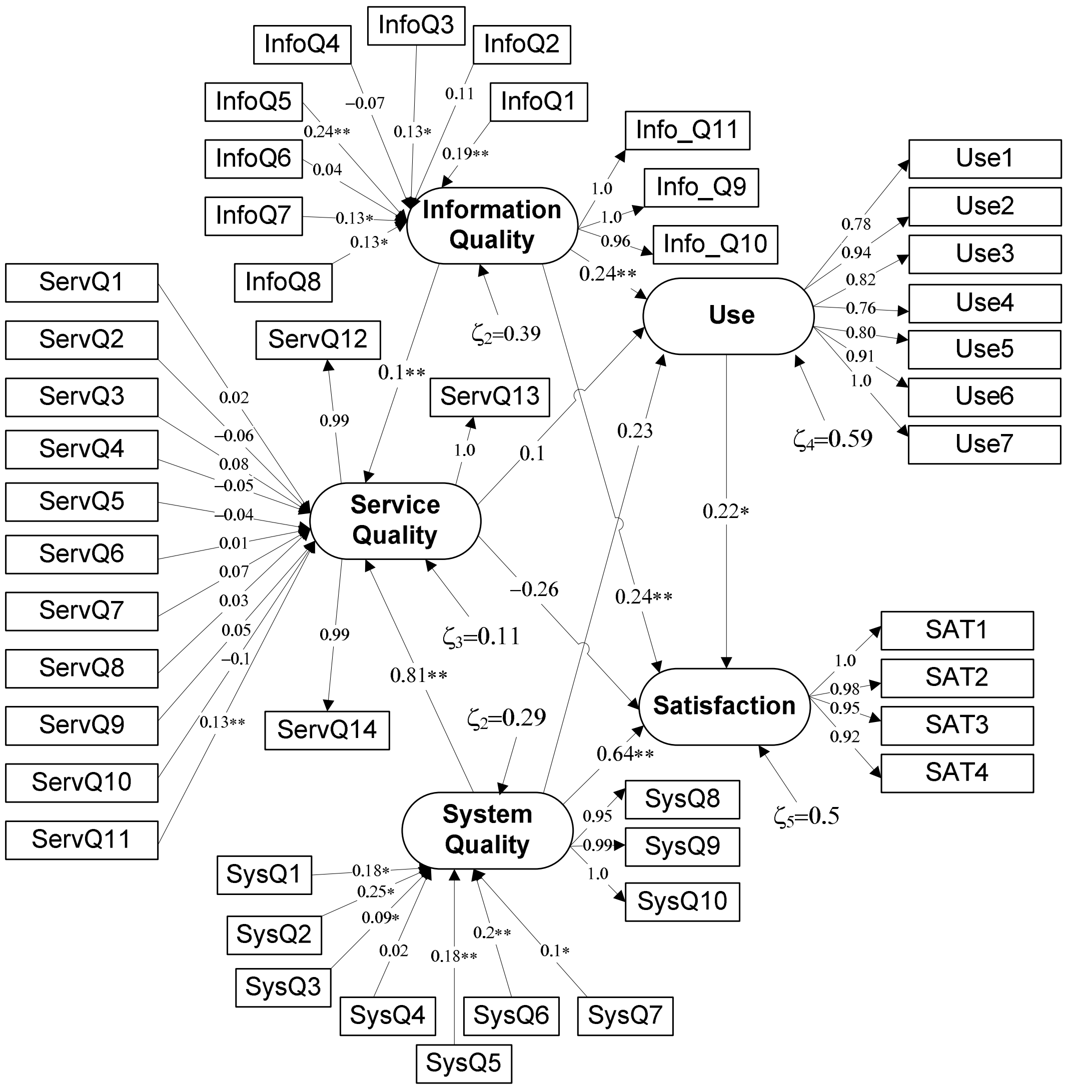

Figure 4-16 LISREL Estimates of Full Model 2

The hypothesis test results are listed in Table 4-12. The result shows the Information Quality and System Quality play important roles in explaining Service Quality. Information Quality has significant impact on Use and Satisfaction while System Quality only has significant impact on and Satisfaction. The result also shows that the Service Quality has no significant impact on both Use and Satisfaction. However, this by no means indicates such impacts do not exist. In fact, the correlations among Service Quality, Use, and Satisfaction are all significant. Both the nomological test of Service Quality and a separate test with only Service Quality, Use, and User Satisfaction show that Service Quality is an important determinant of these two IS Success variables. Again, the insignificant impact of Service Quality on Use and User Satisfaction shown in full model 2 could be caused by several reasons as we have discussed in the section of full model 1 assessment. In addition, few studies like us have included measures of both Intention to Use and Use in the one study. Putting them together in one instrument might confuse the subjects in answering the survey quesitons. Such confusion could be another cause of the problem of not showing Service Quality as an important determinant of Use and User Satisfaction in full model 2. Besides those reasons, some features of our online learning system were made mandatory for our subjects to use at the time of this study. This might cause bias in their answering survey questions related to system use. The future study should focus on assessing subjects' experience of using those non-mandatory features and minimize such bias.

The results of the hypothesis test of full model 2 are listed in Table 4-12.

Table 4-12 Hypothesis Test of Full Model 2

Hypothesis #	Hypothesis	Result
H3b	Service quality has a positive impact on Use.	Not supported
H4	Service quality has a positive impact on User Satisfaction.	Not supported
H5	User has a positive impact on User Satisfaction	Supported
H7	Information Quality has a positive impact on User Satisfaction	Supported
H8b	Information Quality has a positive impact on Use	supported
H9	System Quality has a positive impact on User Satisfaction	Supported
H10b	System Quality has a positive impact on Use	Not Supported

Overall, support of our hypotheses from our test results is mixed. All tests show that both Information Quality and System Quality have significant impacts on Service Quality. However, the mediator role of Service Quality is only partially supported. In particular, the results only support a mediation role of Service Quality between Information Quality and Intention to Use and the between Information Quality and Use. For those lack of support we have discussed several possible causes. We also tested less complicated models (Figure 9-1 and Figure 9-2) without direct paths from Information Quality and System Quality to those IS Success outcome variables. These models bear the assumption of the full mediator role of Service Quality. The hypotheses are better supported by those models. Therefore, we suspect the complexity of the model might also be a cause for insigificant estimate of Service Quality as a mediator in most hypotheses.

In addition, we tested the original DeLone&McLean 2003 IS Success Models (see Figure 9-3 and Figure 9-4 in Appendix D), we found that DeLone&McLean models under our tests performed less well than all other models we have tested. Although the model without direct paths from Information Quality and System Quality to IS Success outcome variables such as Intention to Use, Use, and Satisfaction (shown in Figure 4-17) looks more parsimonious, the results of our tests do not favor it significantly (i.e., Service Quality only mediates the relationship between Information Quality and IS success outcome variables) over some other model (as shown in Figure 2-7). Further research and tests are needed for clarifying which model would be more appropriate for measuring IS Success in an online service environment.

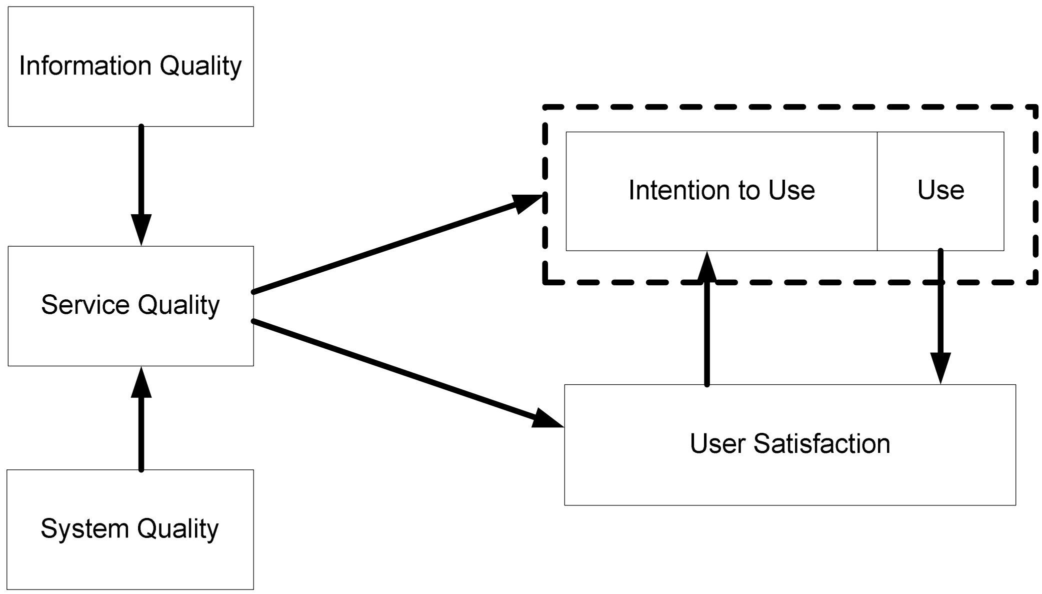

Figure 4-17 - Full Model with Better Parsimony

5. CONCLUSION

5.1 Contribution

This study has attempted to make three main contributions to the existing knowledgebase of IS quality and IS Success. First, through theoretical discussions of how Service Quality, Information Quality, and System Quality are related to each other and to ISM outcomes, this research hopefully contributes to a deeper theoretical understanding of IS Service Quality, System Quality, and Information Quality. In particular, this research attempts to build a long needed theoretical base for IS quality studies. Second, we have developed a comprehensive IS quality instrument. The nomlogoical tests show our instrument well duplicates the results found in previous other studies of IS Succes involving IS quality constructs. Overall, this instrument is well validated in this study. It should be valuable for bother IS researchers and practitioners to effectively measure and evaluate major IS quality dimensions such as Information Quality, System Quality, and Service Quality as well as their corresponding inter-relationships and impacts on IS Success outcome variables in IT enabled service contexts. Third, empirical part of research contributes an assessment and validation to IS quality models including a model derived directly from DeLone and McLean's 2003 ISM and a model based on our theorizing of IS quality. Our results show that Information Quality and System Quality are important determinants of Service Quality in an online service environment. These results could help explain why many later studies of Service Quality in online service environments have seeked those Information Quality and System Quality measures as part of their Service Quality measures. Inconsistent ways of reusing those measures for different constructs could create unncessary knowledge gaps in the field and confuse both researchers and practitioners in selecting appropriate measures in their own studies. We hope this research has cleared up this muddy situation a little bit and shedded some lights for those who are interested in the similar studies.

The main problem that we have encountered in this study is that the hypothesized mediator role of Service Quality is only partially supported. We have discussed several causes of it. Besides those reasons, addition causes might exist. One possibility could be that the online learning system we used in this study is perceived as a low quality system in general by subjects. Certainly, being able to find part of mediation effects of Service Quality with such a low quality system is encouraging. However, it is not clear to what degree it has affected our ability to detect the rest part of mediation effects of Service Quality. Additional causes might need to be examined in future studies. For example, future study might examine why the impact of Service Quality on IS Success outcome variables such as Intention to Use, Use, and Satisfaction becomes insignificant when the direct paths from Information Quality and System Quality to those outcome variables are present.

Overall, with our development and tests of the model derived from DeLone and McLean 2003 ISM, we fill an important research gap. The testing of our proposed alternative model provides an assessment on whether exchange theory can serves as a reasonable theoretical base for reconceptualizing IS quality concepts and their relationships with other variables such as Intention to Use, Use, and User Satisfaction. This point of view provides a coherent theory base and empirical support. Through this research, we examined how different IS quality constructs are related to each other and how they affect downstream constructs such as Use, Intention to Use, and User Satisfaction.

Our research could also benefit practitioners. With the emergence of cloud computing, IS companies such as Microsoft, IBM, Oracle, etc. with their traditional business focus on providing IS products either have adopted or are migrating to a new kind of business models with focus on providing IS services online. This change has challenged our traditional understanding of services and evaluation of service performance in businesses (Laudon and Traver 2010). Our findings showed that the use of traditional SERVQUAL instrument could be questionable in evaluating the Service Quality in an online service environment. Moreover, we found that Information Quality and Service Quality play important roles in determining Service Quality in such kind of environments. For IS practitioners of providing or using those online services, these findings would provide them some insights to make more informative decisions on how to evaluate and improve the quality of their online services as well as the effectiveness of IS as a service channel.

5.2 Limitation and Future Research

One main limitation for this research is that it is not a full test of DeLone and McLean's 2003 ISM. The original D&M ISM has the ambitious and laudable goal of better assessment of the effectiveness of information systems that is beyond this dissertation research. Therefore, future empirical studies that extend this research may be able to verify the full D&M 2003 ISM, the model that involves the construct of Net Benefits, which is the only piece missded out in this study. Our findings and assessment of the model are also subject to several empirical limitations such as the sample limitation, limited test scenarios, etc. For example, although we have discussed several possible IT-enabled service scenarios (e.g., Figure 2-3, Figure 2-4, etc.) in our theoretical development section, we have yet been able to test all of them. To see how the impact of human support service declines and gets overwhelmed by the automated service system, the future study might choose a test scenario that involves an organization is in or has accomplished a transition from human oriented service to automated service with IT. Our results certainly require further verification in those future studies with different samples and different IT-enabled service scenarios.

Besides the above limitations we also encountered some problems. One problem that we didn't realize is that many subjects might not have sufficient human support service experience to answer SERVQUAL questions appropriately. How serious this lack of control of selecting subjects with appropriate human support service experience would be in biasing our research result has yet to see. The future study could include such a control and test how the results are different from the ones in the current study.

Although the original DeLone and McLean's IS Success Model has been proposed for decades, tests of their model have been relatively limited. The tests of their latest 2003 IS Success Model have been even fewer. Indeed, the complexity of their model might have made it difficult to test it all in one single study. For example, the concept of Service Quality in the DeLone and McLean 2003 IS Succes model is defined at a global level, which include various services related to all information systems. Studies like ours typically test it at individual level, which is in a scenario with one system. How the quality of those individual level services would aggregate to the quality of service at a global level has yet to be explored. Also, the reciprocal relation between Intention to Use/Use and User Satisfaction as implied in their study might need longitudinal data to test it. Therefore, to completely and truthfully test the DeLone and McLean 2003 IS Success model might need a multilevel and longitudinal study, which is quite challenging in both data collection and model assessment. However, this shouldn't be the excuse to prevent one from making an effort toward a full test of their model to fill the research gaps and broaden our knowledge base of understanding and measuring IS success. The advance in this part should benefit both researchers and practitioners in IS field in answering the questions and criticisms about the importance of IS and performance evaluations of IS (Benbasat and Zmud 2003; Carr 2003; Agarwal and Jr 2005). The emergence of new business models with focus on online service has not changed the importance of this decade old topic. It makes IS success an even more important topic to help us understand how different IS components might impact sustainability and profitability of IT enabled service oriented business models. With this being said, the major attempt of our current research is to hopefully bring us one step closer toward better understanding of this topic.

6. APPENDIX A – Questionnaire

Here we provide a representative list of IS quality measures examined by a set of 35 IS studies. A full list of measures will be provided in the final dissertation with a comprehensive examination of existing IS studies.

Measures	Construct	Example IS Studies
Information Relevance	Information Quality	Feltham (1968), Zmud (1978)
Information Timelines	Information Quality	Feltham (1968), Gallagher (1974), Schewe (1976), Ahituv (1980)
Information accuracy	Information Quality	Feltham (1968), Zmud (1978), Ives et al (1980)
Information quantity	Information Quality	Gallagher (1974), Schewe (1976)
Information format	Information Quality	Gallagher (1974), Zmud (1978), Ahituv (1980)
Information reliability	Information Quality	Gallagher (1974), Schewe (1976)
Information aggregation	Information Quality	Schewe (1976), Ahituv (1980)
System response time	System Quality	Schewe (1976)
System reliability	System Quality	Srinivasan (1985)
System accessibility	System Quality	Srinivasan (1985)
System efficiency	System Quality	Zahedi (1985)
System flexibility	System Quality	Swanson (1987)
Ease of use	System Quality	Doll and Torkzadeh (1988)
Technical competence	Service Quality	Schewe (1976)
Reliability of IS department	Service Quality	Kettinger and Lee (1994), Pitt and Watson (1995)
Responsiveness of IS department	Service Quality	Kettinger and Lee (1994)
Assurance of IS department	Service Quality	Kettinger and Lee (1994), Pitt and Watson (1995)
Empathy of IS department	Service Quality	Kettinger and Lee (1994), Pitt and Watson (1995)
Attitude of IS staff	Service Quality	Ives et al. (1983)
Communication with IS staff	Service Quality	Ives et al. (1983)
Personal control of IS services	Service Quality	Ives et al. (1983)

An example questionnaire is provided in this section. The full questionnaire will be provided in the final dissertation.

Rating Questionnaire

Your task in this exercise is to categorize statements about information systems (IS) quality and the GSU uLearn system (formerly known as Vista and WebCT). There are three types of IS quality. INFORMATION QUALITY is the information output value generated by an information system in a service exchange with its user. SYSTEM QUALITY is the technical value provided by an IS in a service exchange. This is the value that an IS exhibits when it is used to assist in the delivery of information to the user. SERVICE QUALITY is the overall value delivered through a series of exchanges between users or customers and service providers. We appreciate your participation.

INSTRUCTIONS:

A. Carefully read each statement.

B. Decide on the extent to which the statement refers to the type of IS quality you are being asked to rate.

C. For each statement, check the box which indicate the extent to which the statement fits the concept of IS quality you are rating.

D. Please remember to rate each statement carefully and not to omit or skip any. If you have any questions, please be sure to ask for help.

EXAMPLE:

Example 1: Here is an example related to how a study participant rates the likelihood / degree that one phrase might fit into two categories of job satisfaction.

DEFINITIONS:

Computer =

A computer is a programmable machine that takes in data and processes it into information we can use.

Cell Phone =

A mobile telephone or cellular telephone (commonly "mobile phone" or "cell phone") is a long-range, portable electronic device used for mobile communication.

Video Player =

A video player is a kind of media player for playing back digital video data from media such as optical discs (for example, DVD, VCD), as well as from files of appropriate formats such as MPEG, AVI, RealVideo, and QuickTime.

In this example, the definitions of Computer, Cell Phone, Video Player are provided above. Now you as study participant are asked to rate how likely iPhone, a multimedia and Internet-enabled quad-band GSM EDGE-supported mobile phone designed and sold by Apple Inc, fits in the categories of Computer, Cell Phone, Video Player.

Note: The iPhone's functions include those of a camera phone and a multimedia player, in addition to text messaging and visual voicemail. It also offers Internet services including e-mail, web browsing, and local Wi-Fi connectivity. User input is accomplished via a multi-touch screen with virtual keyboard and buttons.

If you feel ***iPhone*** fits into the category of ***Computer*** “much.” Then, the rating is answered as shown in the following:

Computer	**N/A**	**Not at all**	**Some**	**Halfway**	**Much**	**Completely**
	|	|	|	|	|	|
1. ***iPhone***	☐	☐	☐	☐	☑	☐

If you feel ***iPhone*** fits into the category of ***Cell Phone*** “completely,” then rating is answered as shown in the following:

Cell Phone	**N/A**	**Not at all**	**Some**	**Halfway**	**Much**	**Completely**
	|	|	|	|	|	|
1. ***iPhone***	☐	☐	☐	☐	☐	☑

If you feel ***iPhone*** fits into the category of ***Video Player*** “Halfway,” then rating is answered as shown in the following:

Video Player	**N/A**	**Not at all**	**Some**	**Halfway**	**Much**	**Completely**
	|	|	|	|	|	|
1. ***iPhone***	☐	☐	☐	☑	☐	☐

Example 2: Here is another example that is directly related to this study in rating IS quality.

DEFINITIONS:

INFORMATION QUALITY –

The user perceived information output values including tangible and intangible values generated by an information system through its interactions with its users.

SYSTEM QUALITY –
The technical capability of IS that is perceived to be valuable by its users in supporting their interactions with the IS.

SERVICE –
A series of interactions that occur between customers and service providers for satisfying customer needs.

SERVICE QUALITY –
The customer perceived overall values including tangible and intangible values that are delivered through a series of exchanges in fulfilling customer services.

In this study, a definition of INFORMATION QUALITY is given above. In the first part, the study participant is asked how likely one phrase "***Difficulty of uLearn***" might fit into **INFORMATION QUALITY** category. If the study participant feels "***Difficulty of WebCT***" fits the concept of **INFORMATION QUALITY** (in the box) about half and half, then the third box to the right as shown below is checked.

INFORMATION QUALITY	**N/A**	**Not at all**	**Some**	**Halfway**	**Much**	**Completely**
1. ***<u>Difficulty</u>*** of uLearn	☐	☐	☐	☑	☐	☐

Then, later, the study participant is asked how likely the same phrase "***Difficulty of uLearn***" might fit into **SYSTEM QUALITY** category. If the study participant feels "***Difficulty of WebCT***" fits the concept of **SYSTEM QUALITY** (in the box) much but not completely, then the second box to the right as shown below is checked.

SYSTEM QUALITY	**N/A**	**Not at all**	**Some**	**Halfway**	**Much**	**Completely**
1. ***<u>Difficulty</u>*** of uLearn	☐	☐	☐	☐	☑	☐

Then, later again, the study participant is asked how likely the same phrase "Difficulty of uLearn" might fit into SERVUCE QUALITY category. If the study participant feels "Difficulty of WebCT" fits the concept of SERVICE QUALITY (in the box) completely, then the first box to the right as shown below is checked.

SERVICE QUALITY	**N/A**	**Not at all**	**Some**	**Halfway**	**Much**	**Completely**
1. ***<u>Difficulty</u>*** of uLearn	☐	☐	☐	☐	☐	☑

Now, begin on the next page. Please remember to rate each statement carefully and not omit or skip any. Use the definition of IS Quality concept given at the top of each page in making your ratings for that page. Thanks again.

RATING QUESTIONNAIRE

Information quality, **system quality**, and **service quality** are commonly viewed by MIS researchers, users / customers as three important quality aspects of an **information system**. The box below lists the definition for each of those quality aspects. A lot of measures have been developed and used by people for measuring those three IS quality aspects. Now suppose the **GSU uLearn** (**WebCT**) **system**, ***a Web-based information system*** required by GSU for students to use, needs to be accessed on its **information quality**, **system quality**, and **service quality** with those measures developed in the past. Your task here is then **to give your personal judgment** on the appropriateness of using those measures to assess **information quality**, **system quality**, and **service quality** of **GSU uLearn** (**WebCT**).

INFORMATION QUALITY - The degree of excellence of the information output. This includes tangible and intangible outputs generated in interactions between an information system and its customers/users.

SYSTEM QUALITY – The degree of excellence of the technical features other than information output features of an information system. This concept captures the features of a system that are important in supporting customer/user interactions with an IS.

SERVICE – A series of interactions that occur between customers/users and service providers.

SERVICE QUALITY – The degree of excellence of the service. This includes tangible and intangible service output delivered through a series of interactions.

Note: *If you don't understand the meaning of an item, you can check **N/A for "Not Applicable".***

Item 1: *<u>Applicability</u>* of output information	**N/A**	**Not at all**	**Some**	**Halfway**	**Much**	**Completely**
	|	|	|	|	|	|
To what extent does the **item 1** measure **INFORMATION Quality?**	☐	☐	☐	☐	☐	☐
To what extent does the **item 1** measure **SYSTEM Quality?**	☐	☐	☐	☐	☐	☐

To what extent does the **item 1** measure **SERVICE Quality?**	☐	☐	☐	☐	☐	☐
Item 2: ***<u>Promptness</u>*** of support team in responding to you, its customers	**N/A**	**Not at all**	**Some**	**Halfway**	**Much**	**Completely**
	|	|	|	|	|	|
To what extent does the **item 2** measure **INFORMATION Quality?**	☐	☐	☐	☐	☐	☐
To what extent does the **item 2** measure **SYSTEM Quality?**	☐	☐	☐	☐	☐	☐
To what extent does the **item 2** measure **SERVICE Quality?**	☐	☐	☐	☐	☐	☐
Item 3: ***<u>Clarity in meaning</u>*** of Output	**N/A**	**Not at all**	**Some**	**Halfway**	**Much**	**Completely**
	|	|	|	|	|	|
To what extent does the **item 3** measure **INFORMATION Quality?**	☐	☐	☐	☐	☐	☐
To what extent does the **item 3** measure **SYSTEM Quality?**	☐	☐	☐	☐	☐	☐
To what extent does the **item 3** measure **SERVICE Quality?**	☐	☐	☐	☐	☐	☐

7. APPENDIX B – Consensus Analysis

The complete result of consensus analysis regarding existing IS quality measures will be listed in this section. Here is an example of representative IS quality measures agreement among existing IS studies

Table 7-1 Results of Consensus Analysis

Measures	Construct	Number of Studies	CVR	Significance
Information Relevance	Information Quality	11	.91	☑
Information Timeline	Information Quality	14	.71	☑
Information Accuracy	Information Quality	16	.76	☑
Information Quantity	Information Quality	12	.83	☑
Information Format	Information Quality	9	.89	☑
Information Reliability	Information Quality	11	.73	☑
Response Time	System Quality	8	.625	☐
Ease of Use	System Quality	8	.88	☑
System Accuracy	System Quality	2	.5	N/A
System Flexibility	System Quality	4	.75	N/A
System Reliability	System Quality	6	1	☑
System Accessibility	System Quality	4	.75	N/A
System Efficiency	System Quality	4	.75	N/A
Responsiveness of IS department	Service Quality	5	1	☑
Reliability of IS department	Service Quality	4	1	N/A
Assurance of IS department	Service Quality	4	1	N/A
Empathy of IS department	Service Quality	4	1	N/A
Tangibles of IS department	Service Quality	4	.5	N/A
Privacy	Service Quality	2	1	N/A

Note: CVR represents content validity ratio; N/A means sample size is too small to make a conclusion whether one measure is significantly agreed among existing IS studies

8. APPENDIX C – Correlation Matrix of System Quality, Information Quality, and Service Quality

Table 8-1 Test Inter-Item and Item-to-Construct Correlation Matrix of System Quality, Information Quality, and Service Quality

	Sys Q1	Sys Q2	Sys Q3	Sys Q4	Sys Q5	Sys Q6	Sys Q7	Sys_Q	IQ1	IQ2	IQ3	IQ4	IQ5	IQ6	IQ7	IQ8	Info _Q	SQ1	SQ2	SQ3	SQ4	SQ5	SQ6	SQ7	SQ8	SQ9	SQ 10	SQ 11	Serv _Q
Reliability (SysQ1)	1																												
Accessibility (SysQ2)	.555	1																											
Responsibility (SysQ3)	.554	.657	1																										
Fun to navigate (SysQ4)	.470	.523	.524	1																									
Easy to use (SysQ5)	.419	.576	.500	.572	1																								
Sophistication (SysQ6)	.524	.572	.549	.643	.645	1																							
Up to date (SysQ7)	.421	.442	.467	.644	.529	.600	1																						
Sys_Q (Construct)	**.757**	**.837**	**.767**	**.706**	**.785**	**.837**	**.687**	**1**																					
Accuracy (IQ1)	.496	.506	.417	.437	.420	.449	.422	.582	1																				
Format (IQ2)	.509	.525	.543	.649	.561	.596	.600	.698	.492	1																			
Useful (IQ3)	.596	.540	.541	.506	.456	.437	.450	.641	.676	.614	1																		
Currency (IQ4)	.484	.507	.460	.524	.561	.564	.527	.659	.643	.575	.591	1																	
Understandable (IQ5)	.548	.499	.463	.396	.438	.390	.347	.579	.497	.386	.575	.531	1																
Completeness (IQ6)	.538	.521	.403	.444	.443	.426	.438	.596	.780	.511	.653	.651	.496	1															
Relevancy (IQ7)	.471	.427	.462	.462	.490	.452	.443	.578	.487	.505	.583	.714	.520	.481	1														
Trustful (IQ8)	.550	.484	.445	.426	.410	.409	.446	.583	.618	.524	.693	.499	.498	.663	.465	1													
Info_Q (Construct)	***.648***	***.626***	***.616***	***.650***	***.628***	***.629***	***.617***	***.797***	***.744***	***.827***	***.805***	***.816***	***.690***	***.702***	***.799***	***.743***	***1***												
Sincere (SQ1)	.378	.426	.534	.462	.340	.466	.423	.533	.289	.355	.317	.374	.267	.248	.252	.309	.401	1											
Promise Time (SQ2)	.379	.403	.465	.390	.371	.426	.364	.507	.320	.250	.310	.395	.310	.272	.281	.299	.380	.807	1										
Willing Help (SQ3)	.339	.343	.405	.338	.241	.375	.335	.426	.310	.195	.290	.329	.270	.267	.270	.343	.345	.740	.749	1									
Never Busy (SQ4)	.325	.402	.468	.390	.292	.404	.367	.471	.262	.223	.268	.312	.253	.237	.227	.288	.322	.790	.752	.791	1								
Safety (SQ5)	.393	.406	.437	.364	.276	.371	.285	.462	.320	.209	.338	.374	.332	.298	.336	.342	.386	.635	.575	.628	.577	1							
Consistency (SQ6)	.347	.363	.418	.356	.263	.369	.368	.443	.269	.220	.311	.302	.291	.263	.232	.303	.332	.752	.741	.768	.734	.684	1						

Knowledge (SQ7)	.345	.318	.389	.323	.263	.319	.341	.410	.276	.232	.304	.339	.299	.264	.270	.318	.356	.708	.684	.755	.723	.658	.791	1					
Operation (SQ8)	.358	.376	.406	.398	.263	.368	.369	.448	.298	.271	.372	.350	.318	.260	.280	.336	.389	.661	.623	.625	.672	.593	.699	.671	1				
Personal_Attention (SQ9)	.293	.312	.392	.396	.255	.361	.377	.409	.207	.235	.267	.316	.223	.208	.290	.275	.329	.682	.624	.672	.721	.552	.698	.695	.746	1			
Best_Interest (SQ10)	.372	.367	.443	.443	.270	.406	.399	.469	.277	.248	.330	.337	.272	.249	.273	.331	.363	.719	.693	.700	.765	.595	.732	.718	.721	.789	1		
Specific_Needs (SQ11)	.340	.401	.427	.456	.408	.469	.424	.518	.310	.334	.341	.454	.312	.303	.314	.347	.435	.664	.635	.649	.625	.609	.699	.704	.638	.657	.688	1	
SERV_Q (Construct)	***.410***	***.469***	***.508***	***.497***	***.423***	***.510***	***.440***	***.581***	***.365***	***.358***	***.393***	***.493***	***.359***	***.332***	***.358***	***.389***	***.487***	***.804***	***.765***	***.742***	***.723***	***.758***	***.732***	***.734***	***.785***	***.713***	***.726***	***.932***	***1***

Note: All correlations are significant at 0.01 level

Table 8-2 Nomological Network Information Quality and System Quality Correlation Matrix

	IQ1	*IQ2*	*IQ3*	*IQ4*	*IQ5*	*IQ6*	*IQ7*	*IQ8*	*SQ1*	*SQ2*	*SQ3*	*SQ4*	*SQ5*	*SQ6*	*SQ7*	*IQ Global 1*	*IQ Global 2*	*IQ Global 3*	*SQ Global 1*	*SQ Global 2*	*SQ Global 3*	*Sat 1*	*Sat 2*	*Sat 3*	*Sat 4*	*IU1*	*IU2*
IQ1	1																										
IQ2	0.714	1																									
IQ3	0.479	0.639	1																								
IQ4	0.47	0.658	0.777	1																							
IQ5	0.514	0.575	0.478	0.51	1																						
IQ6	0.594	0.59	0.668	0.646	0.599	1																					
IQ7	0.469	0.494	0.615	0.66	0.503	0.665	1																				
IQ8	0.523	0.526	0.495	0.463	0.368	0.547	0.476	1																			
SysQ1	0.471	0.48	0.489	0.526	0.504	0.585	0.538	0.526	1																		
SysQ2	0.438	0.512	0.513	0.513	0.522	0.538	0.483	0.487	0.545	1																	
SysQ3	0.479	0.466	0.426	0.406	0.539	0.541	0.44	0.461	0.553	0.657	1																
SysQ4	0.478	0.537	0.447	0.446	0.651	0.519	0.423	0.396	0.477	0.525	0.518	1															
SysQ5	0.505	0.572	0.432	0.426	0.56	0.44	0.4	0.42	0.399	0.572	0.497	0.567	1														
SysQ6	0.46	0.563	0.452	0.416	0.592	0.438	0.393	0.374	0.518	0.573	0.543	0.636	0.632	1													
SysQ7	0.462	0.536	0.442	0.444	0.598	0.448	0.452	0.345	0.419	0.438	0.464	0.632	0.525	0.58	1												
IQ Global 1	0.531	0.564	0.55	0.486	0.544	0.558	0.521	0.505	0.5	0.671	0.569	0.588	0.586	0.608	0.493	1											
IQ Global 2	0.631	0.613	0.52	0.5	0.579	0.56	0.527	0.514	0.529	0.615	0.568	0.563	0.644	0.637	0.559	0.813	1										
IQ Global 3	0.54	0.537	0.496	0.471	0.565	0.54	0.502	0.424	0.415	0.59	0.577	0.562	0.564	0.586	0.476	0.805	0.777	1									
SQ Global 1	0.545	0.571	0.5	0.484	0.702	0.59	0.527	0.494	0.569	0.637	0.629	0.546	0.621	0.653	0.54	0.69	0.727	0.763	1								
SQ Global 2	0.544	0.563	0.513	0.528	0.71	0.63	0.556	0.491	0.566	0.653	0.591	0.551	0.637	0.633	0.546	0.714	0.736	0.736	0.886	1							
SQ Global 3	0.576	0.638	0.525	0.543	0.656	0.598	0.553	0.475	0.602	0.705	0.604	0.593	0.62	0.706	0.552	0.766	0.775	0.771	0.865	0.901	1						
Sat 1	0.461	0.497	0.424	0.464	0.538	0.552	0.37	0.482	0.611	0.621	0.549	0.512	0.51	0.557	0.386	0.556	0.552	0.481	0.581	0.592	0.66	1					
Sat 2	0.488	0.495	0.401	0.462	0.513	0.54	0.427	0.45	0.551	0.552	0.523	0.504	0.514	0.507	0.416	0.568	0.569	0.529	0.538	0.554	0.626	0.887	1				
Sat 3	0.438	0.463	0.413	0.422	0.503	0.535	0.381	0.454	0.56	0.543	0.541	0.455	0.518	0.488	0.378	0.537	0.577	0.486	0.564	0.548	0.603	0.852	0.848	1			
Sat 4	0.463	0.442	0.373	0.407	0.504	0.513	0.385	0.405	0.58	0.591	0.508	0.48	0.516	0.492	0.417	0.526	0.544	0.481	0.562	0.565	0.645	0.834	0.801	0.782	1		
IU1	0.397	0.404	0.409	0.332	0.575	0.506	0.34	0.33	0.4	0.542	0.552	0.463	0.436	0.441	0.389	0.498	0.479	0.481	0.568	0.535	0.553	0.509	0.456	0.476	0.47	1	
IU2	0.494	0.534	0.468	0.405	0.528	0.465	0.335	0.41	0.399	0.478	0.413	0.54	0.494	0.513	0.478	0.557	0.55	0.52	0.562	0.562	0.592	0.488	0.485	0.45	0.45	0.676	1

9. APPENDIX D – Alternative Models

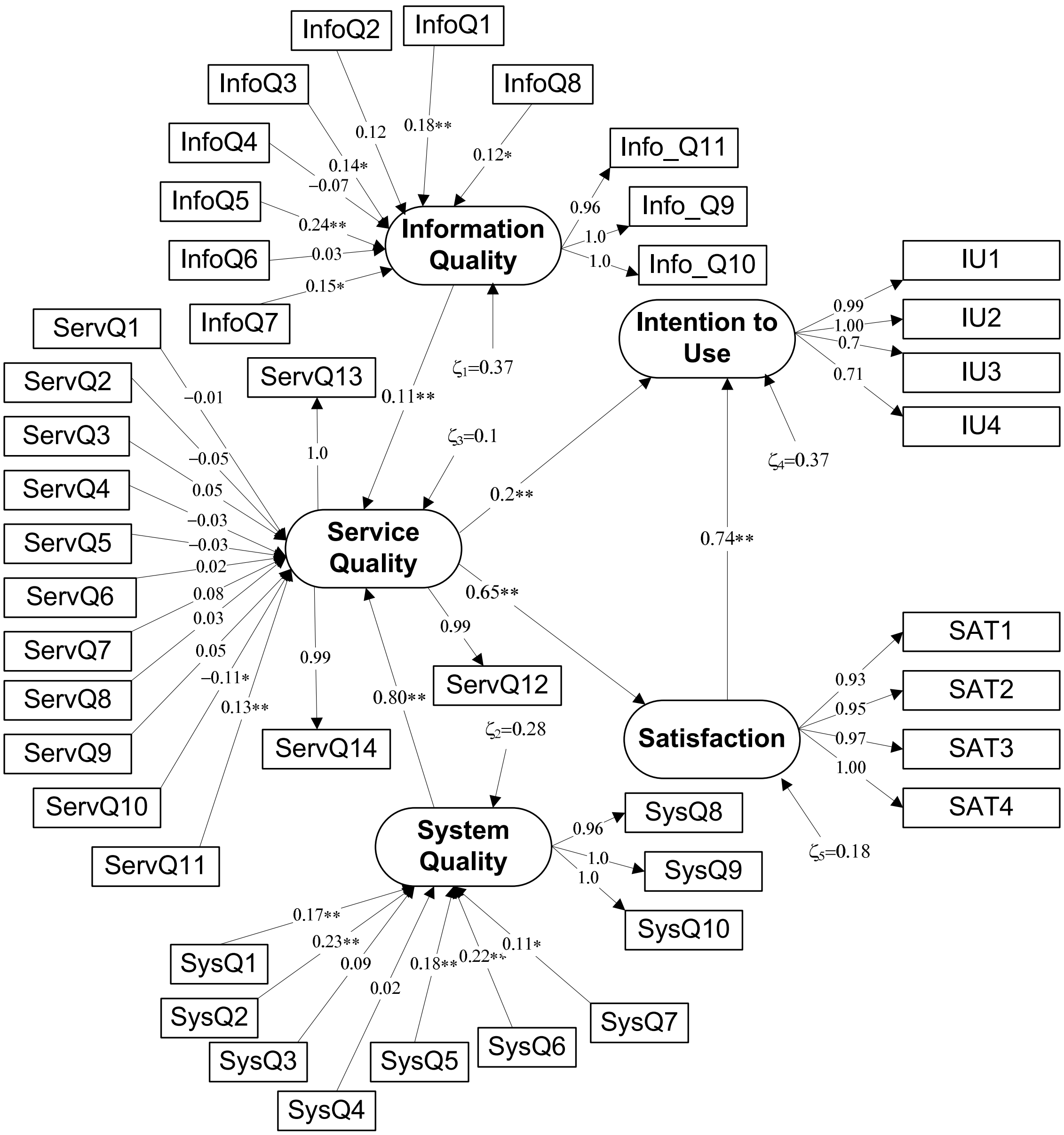

Figure 9-1 LISREL Estimates of Alternative Full Model 1

Table 9-1 Fit Indices of Alternative Full Model 1

Fit Index	Cutoff	Results
χ^2*(d.f., p)*		1029 (530, 0.00)
χ^2/ *d.f.*	≤ 5.0	2.28
NFI	≥ 0.95	0.88
CFI	≥ 0.95	0.92
GFI	≥ 0.9	0.81

AGFI	>0.8	0.66
SRMR	≤ 0.05	0.1
RMSEA	≤ 0.05	0.068

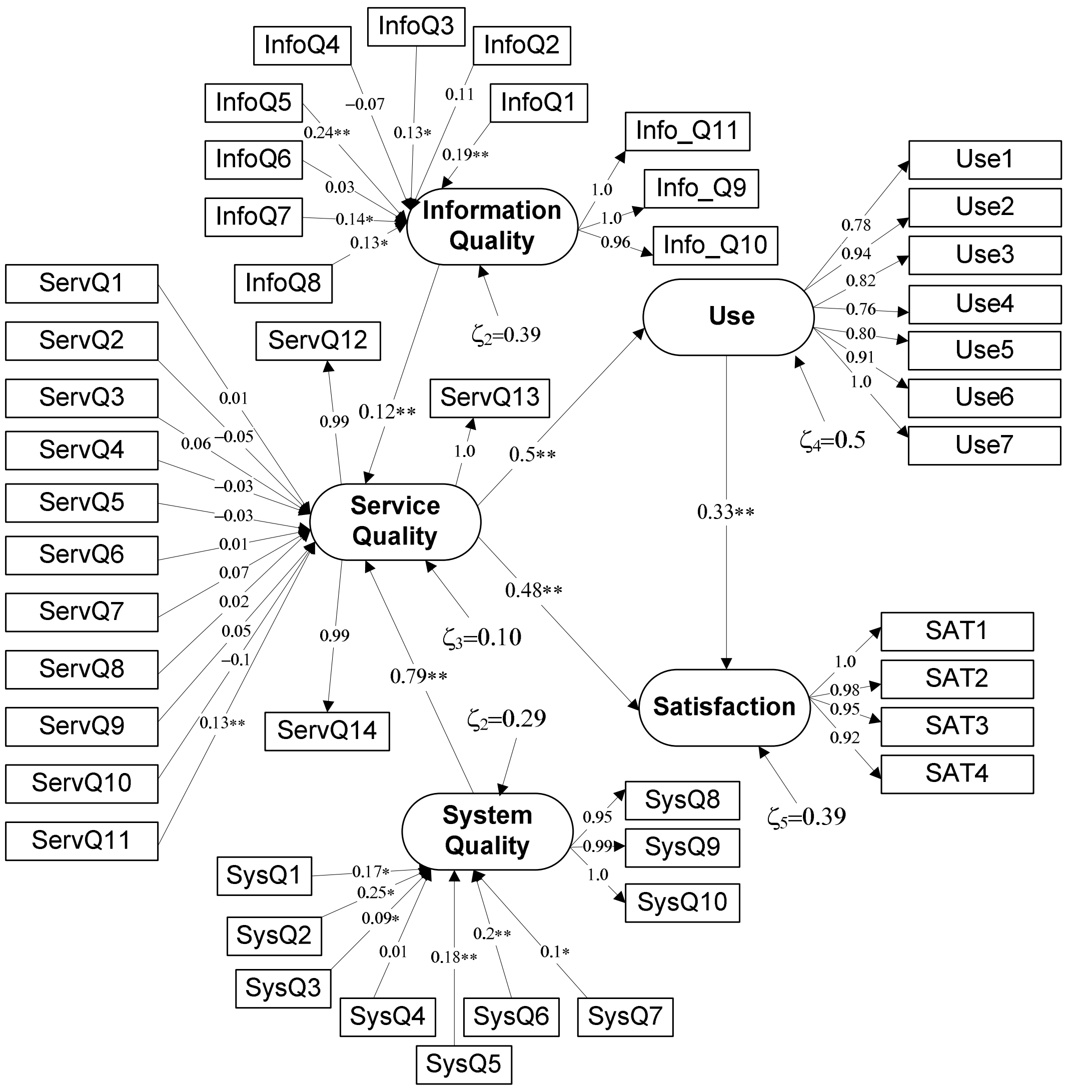

Figure 9-2 LISREL Estimates of Alternative Full Model 2

Table 9-2 Fit Indices of Alternative Full Model 2

Fit Index	Cutoff	Results
χ^2(d.f., p)		1174.17 (659, 0.00)
χ^2/ d.f.	≤ 5.0	1.78
NFI	≥ 0.95	0.87
CFI	≥ 0.95	0.92
GFI	≥ 0.9	0.81
AGFI	>0.8	0.68
SRMR	≤ 0.05	0.09
RMSEA	≤ 0.05	0.061

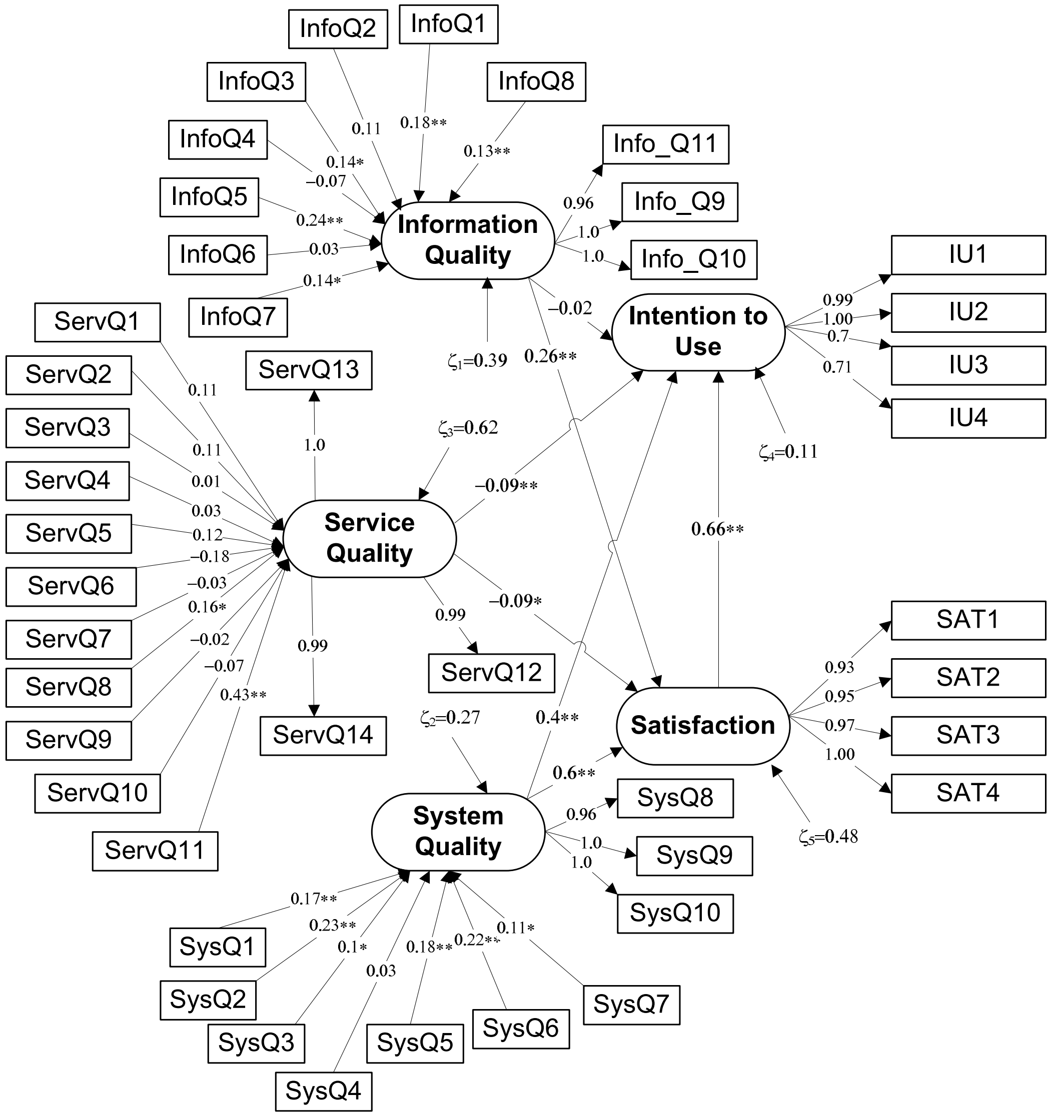

Figure 9-3 LISREL Estimate of DeLone & McLean Full Model 1

Table 9-3 Fit Indices of DeLone & McLean Full Model 1

Fit Index	Cutoff	Results
χ^2*(d.f., p)*		1151.19 (528, 0.00)
χ^2/ *d.f.*	≤ 5.0	2.18
NFI	≥ 0.95	0.86
CFI	≥ 0.95	0.90
GFI	≥ 0.9	0.79
AGFI	>0.8	0.63
SRMR	≤ 0.05	0.14
RMSEA	≤ 0.05	0.076

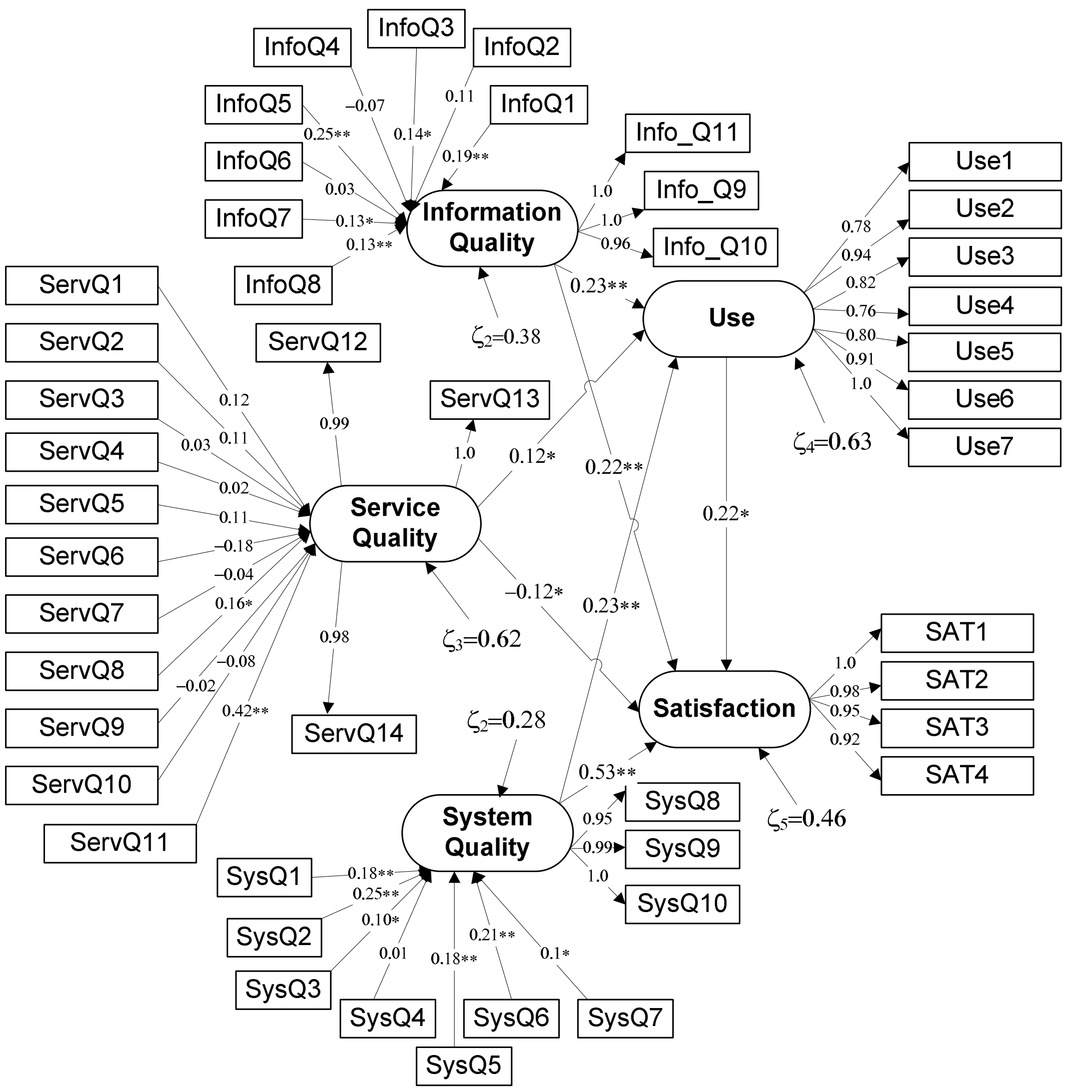

Figure 9-4 LISREL Estimates of DeLone & McLean Full Model 2

Table 9-4 Fit Indices of DeLone & McLean Full Model 2

Fit Index	Cutoff	Results
χ^2(*d.f., p*)		1313.74 (657, 0.00)
χ^2/ *d.f.*	≤ 5.0	2.00
NFI	≥ 0.95	0.84
CFI	≥ 0.95	0.89
GFI	≥ 0.9	0.78
AGFI	>0.8	0.65
SRMR	≤ 0.05	0.13
RMSEA	≤ 0.05	0.069

10.**APPENDIX E- Qustionnaire for Full Model Test**

Georgia State University

Department of Computer Information System

Title: Evaluation of an online information system

Directions: The statements in the following sections ask your satisfaction, quality evaluation with the uLearn, also known as WebCT, an online learning service system provided by GSU. Please think about your past experience with uLearn. Please circle a number that best describes your evaluation of the factor in each statement. There are no right or wrong answers. (For example, for Item Q1, if you are more *satisfied* than *dissatisfied* with *uLearn*, **circle a number** of the higher end of the *Dissatisfied/Satisfied* scale, if you are more *displeased* than *pleased*, circle a number on the lower end of the *displeased/pleased* scale). Base your evaluation on your first impression.

Q1. In general, with *uLearn* I am …												
Very dissatisfied	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	*Very satisfied*
Very displeased	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	*Very pleased*

Frustrated	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	*Contented*
Q2. In general, I feel … with *uLearn*												
Terrible	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	*Delighted*
Q3. Based on all my experience with *uLearn*, I would …												
Never recommend to others	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	*Definitely recommend to others*
Never use it if I can	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	*Definitely use it if I can*
Q4. In general, I am … with the Web-based information provided by *uLearn*												
Very dissatisfied	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	*Very satisfied*
Very displeased	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	*Very pleased*
Frustrated	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	*Contented*
Disappointed	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	*Delighted*
Q5. In general, I am … with all features and functions provided by *uLearn*												
Very dissatisfied	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	*Very satisfied*
Very displeased	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	*Very pleased*
Frustrated	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	*Contented*
Never use it if I can	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	*Definitely use it if I can*

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly Agree
Q6. When I was using *uLearn*, I used features that helped me communicate with my instructor regarding class learning issues (*e.g., uLearn's* E-mail or online discussion board or announcement board).	1	2	3	4	5	6	7
Q7. When I was using *uLearn*, I used features that helped me communicate with my classmates (*e.g., uLearn's* E-mail or online discussion board).	1	2	3	4	5	6	7
Q8. When I was using *uLearn*, I used features that helped me plan and schedule class events (*e.g., uLearn's* calendar system).	1	2	3	4	5	6	7
Q9. When I was using *uLearn*, I used features that helped me track my learning progress (*e.g., grade listing, assignment management, etc*).	1	2	3	4	5	6	7
Q10. When I was using *uLearn*, I used features that helped me manage my learning materials (*e.g., file management*).	1	2	3	4	5	6	7
Q11. To communicate with my classmates, I used *uLearn* most of time (*e.g.,* email, message discussion board, etc).	1	2	3	4	5	6	7
Q12. *uLearn* is the system that I used most often to manage my learning progress.	1	2	3	4	5	6	7
Q13. I would like to use uLearn to manage my course materials even if it is not required by GSU.	1	2	3	4	5	6	7
Q14. I would recommend others to use uLearn's email and discussion board system to communicate for learning classes even if it is not required by GSU.	1	2	3	4	5	6	7
Q15. uLearn's text and images (e.g., labels of buttons and menus, page	1	2	3	4	5	6	7

contents, etc) are relevant to their intended purposes.							
Q16. uLearn's text and images (e.g., labels of buttons and menus, page contents, etc) are up-to-date (i.e., no outdated information).	1	2	3	4	5	6	7
Q17. uLearn's text and images (e.g., labels of buttons and menus, page contents, etc) are accurate (i.e., few errors).	1	2	3	4	5	6	7
Q18. uLearn's text and images (e.g., labels of buttons and menus, page contents, etc) are complete (i.e., no missing information).	1	2	3	4	5	6	7
Q19. uLearn's Web format is excellent.	1	2	3	4	5	6	7
Q20. uLearn's text and images (e.g., labels of buttons and menus, page contents, etc) are useful (i.e., do help your work).	1	2	3	4	5	6	7
Q21. uLearn's text and images (e.g., labels of buttons and menus, page contents, etc) are trustful.	1	2	3	4	5	6	7
	Strongly disagree	**Disagree**	**Slightly disagree**	**Neutral**	**Slightly agree**	**Agree**	**Strongly Agree**
Q22. uLearn's text and images (e.g., labels of buttons and menus, page contents, etc) are consistent with each other.	1	2	3	4	5	6	7
Q23. uLearn's text and images (e.g., labels of buttons and menus, page contents, etc) are understandable (i.e., easy to understand and comprehend).	1	2	3	4	5	6	7
Q24. uLearn is reliable (i.e., few breakdowns).	1	2	3	4	5	6	7
Q25. uLearn is flexible in handling users various requests.	1	2	3	4	5	6	7
Q26. uLearn provides high integration of functions and data (i.e., ability to	1	2	3	4	5	6	7

import / export data of different formats).							
Q27. uLearn is highly accessible to its users.	1	2	3	4	5	6	7
Q28. Response of uLearn to its users' request is fast.	1	2	3	4	5	6	7
Q29. uLearn is visually attractive or fun to navigate.	1	2	3	4	5	6	7
Q30. uLearn is easy to use.	1	2	3	4	5	6	7
Q31. uLearn is capable of handling complicated tasks.	1	2	3	4	5	6	7
Q32. uLearn support team has up-to-date hardware and software.	1	2	3	4	5	6	7
Q33. uLearn support team's physical facilities are visually appealing.	1	2	3	4	5	6	7
Q34. uLearn support team are well dressed and neat in appearance.	1	2	3	4	5	6	7
Q35. The appearance of the physical facilities of the uLearn support team is in keeping with the kind of service provided.	1	2	3	4	5	6	7
Q36. When uLearn support promise to do something by a certain time, they do so.	1	2	3	4	5	6	7
Q37. When users have a problem, uLearn support team shows a sincere interest in solving it.	1	2	3	4	5	6	7
Q38. uLearn support team is dependable.	1	2	3	4	5	6	7
Q39. uLearn support team provides their service at the time they promise to do.	1	2	3	4	5	6	7
Q40. uLearn support team insists on error-free records.	1	2	3	4	5	6	7

Q41. uLearn support team tells users exactly when service will be performed.	1	2	3	4	5	6	7
	Strongly disagree	**Disagre e**	**Slightly disagree**	**Neutral**	**Slightl y agree**	**Agree**	**Strongl y Agree**
Q42. uLearn support team gives prompt service to users.	1	2	3	4	5	6	7
Q43. uLearn support team is always willing to help users.	1	2	3	4	5	6	7
Q44. uLearn support team is never too busy to respond to users' requests.	1	2	3	4	5	6	7
Q45. uLearn support team instills confidence in users.	1	2	3	4	5	6	7
Q46. You feel safe in your transactions with uLearn support team (i.e., account application, maintenance, etc).	1	2	3	4	5	6	7
Q47. uLearn support team is consistently courteous with users.	1	2	3	4	5	6	7
Q48. uLearn support team has the knowledge to do their job well.	1	2	3	4	5	6	7
Q49. uLearn support team gives users individual attention.	1	2	3	4	5	6	7
Q50. uLearn support team has operation hours convenient to all users.	1	2	3	4	5	6	7
Q51. uLearn support team give users personal attention.	1	2	3	4	5	6	7
Q52. uLearn support team has the users' best interest at heart.	1	2	3	4	5	6	7
Q53. uLearn support team understand the specific needs of its users.	1	2	3	4	5	6	7
Q54. Overall, I would give the information quality from uLearn high marks.	1	2	3	4	5	6	7
Q55. Overall, I would give the information provided by uLearn a high rating in terms of quality.	1	2	3	4	5	6	7

Q56. In general, uLearn provides me with high-quality information.	1	2	3	4	5	6	7
Q57. In terms of system quality, I would rate uLearn highly.	1	2	3	4	5	6	7
Q58. Overall, uLearn is of high quality.	1	2	3	4	5	6	7
Q59. Overall, I would give the quality of uLearn a high rating.	1	2	3	4	5	6	7
Q60. In general, I would consider services of uLearn as high quality services.	1	2	3	4	5	6	7
Q61. Overall, uLearn services are of high quality.	1	2	3	4	5	6	7
Q62. Overall, I would give the quality of uLearn services a high rating.	1	2	3	4	5	6	7

Please provide the following information about yourself.

	Male	**Female**
1. What is your gender?	❑	❑

2. How many years have you used **uLearn**? ___________ **years**

	Not Very Experienced			Somewhat Experienced			Very Experienced
3. How much experience do you have on using **uLearn** (WebCT)?	❑	❑	❑	❑	❑	❑	❑

Thank you for completing all the questionnaires!
Please return them to the researcher.

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